DEC STD 080-1 Digital Product Safety Industrial Control Equipment - Design Criteria

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ABSTRACT: Defines safety design criteria to be applied to all Digital industrial control equipment.

APPLICABILITY: This standard applies to all products sold by Digital for the industrial control market. Some product areas, such as software, furnishings, or other market areas, may not have applicable requirements within this document. However, general principles of safety still apply. The requirements of this standard apply to all products in Phase 0 or Phase 1 on the data this standard is approved. See DEC STD 080-0, subhead 2.1.1, Product Safety Standards Policy.

STATUS: APPROVED 15-Feb-1991; use VTX SMC for current status.

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NOTES

Words in the text of this document shown in all capital letters are defined in the glossary.

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Responsible Person:	Rich Trainor
Authors:	Tom Feindel, Rich Trainor

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Rich Trainor - EIC/E Regulatory Services

Eric Williams - Standards Process Manager

Direct requests for further information to:

Rich Trainor
Use $ VTX ELF for the latest location information.

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CONTENTS

1 ENCLOSURES 1
1.1 GENERAL 1
1.2 CAST METAL 1
1.3 SHEET METAL 2
1.4 POLYMERIC MATERIAL 4
1.5 DOORS AND COVERS 5
2 FRAME AND ENCLOSURE 6
2.1 OPENINGS 7
2.1.1 Bottom 7
2.1.2 Top 10
2.1.3 Sides 11
2.1.4 Cathode Ray Tube (CRT) Enclosures 11
2.2 NON-VENTILATION OPENINGS 12
2.3 VENTILATION OPENINGS 12
2.3.1 Ventilation Openings Using a Fuse or Circuit Breakers 13
2.3.2 Barriers Used With Ventilation Openings 14
2.3.3 Forced Ventilation 14
2.4 WINDOWS 14
2.4.1 Observation Windows 14
2.4.2 Mechanical Windows 15
2.5 GASKETS 15
3 SPECIFIC ENCLOSURES 15
3.1 UL TYPE 1, IEC CLASS IP2X 15
3.2 UL TYPE 2, IEC CLASS IP22, CSA ENCLOSURE 2 16
3.3 UL TYPE 3, IEC CLASS IP24 16
3.4 UL TYPE 3R, IEC CLASS IP23, CSA ENCLOSURE 3 16
3.5 UL TYPE 3S 17
3.6 UL TYPES 4, 4X, 6, 6P, and 11, IEC IP25, CSA ENCLOSURE 4 17
3.7 UL TYPE 12, IEC IP65, CSA ENCLOSURE 5 17
3.8 UL TYPE 13, IEC IP54 18
4 ENCLOSURE PERFORMANCE 18
4.1 FLAMMABILITY 20
4.1.1 Ignition Sources 20
4.1.2 Internal Parts 21
4.1.3 Decorative Parts 22
4.1.4 Enclosure Material 23
5 PROTECTION AGAINST CORROSION 24
6 OUTDOOR ENCLOSURES 24
7 BONDING 26
8 FIELD WIRING 27

9 PROVISIONS FOR MOUNTING 28
10 INSULATING MATERIAL 29
11 ACCESSIBILITY 29
12 LIVE PARTS 30
12.1 PRIMARY CIRCUITS 31
12.2 PRIMARY POWER ISOLATION 31
12.2.1 Multiple Supply Sources 33
12.2.2 Multi-voltage Equipment 34
13 HAZARDS 35
13.1 CHEMICAL HAZARDS 35
13.2 RADIATION HAZARDS 36
13.2.1 X-Radiation (Ionizing Radiation) 36
13.2.2 RF Radiation (Non-ionizing Radiation) 37
14 OVERCURRENT PROTECTION FOR POWER SUPPLIES 37
14.1 POWER SUPPLY - PRIMARY CIRCUITS 38
14.2 POWER SUPPLY - SECONDARY CIRCUITS 38
15 PRIMARY CIRCUIT CAPACITORS 39
16 FUSEHOLDERS 39
17 INTERNAL WIRING 40
18 SPLICE INSULATION 40
19 EXTERNAL INTERCONNECTIONS 41
19.1 OPEN EQUIPMENT 41
19.2 ENCLOSED EQUIPMENT 41
19.3 INTERCONNECTING CORDS AND CABLES 41
20 TRANSFORMERS 41
21 BLOWER MOTORS 42
22 SUPPLY CONNECTORS - WIRING TERMINALS AND LEADS 42
22.1 PERMANENTLY CONNECTED EQUIPMENT 42
22.2 CORD-CONNECTED EQUIPMENT 44
22.3 CORD-CONNECTED PROGRAMMING AND DIAGNOSTIC UNITS 44
23 SWITCHES AND CONTROLS 45
24 ELECTRIC LIGHTING EQUIPMENT 45
25 SECONDARY CIRCUITS 45
26 LIMITED ENERGY 45
27 BATTERY POWER 45
28 DERIVED LOW VOLTAGE 46

28.1 MACHINE EXTRA-LOW VOLTAGE (MELV) 46
28.1.1 Requirements 46
28.1.2 Insulation 47
28.1.3 Shields Connected to Safety Earth Ground and Other Protection Means 48
28.2 FUNCTIONAL EXTRA-LOW VOLTAGE (FELV) Circuit 48
28.3 INTERCONNECTION WITH NON-MELV CIRCUITS 48
28.4 TELECOMMUNICATION CIRCUIT INTERCONNECTION 48

29 SEPARATION OF CIRCUITS 49

30 ISOLATION DEVICES 50

31 SPACINGS (CREEPAGE AND CLEARANCE DISTANCES) 51

32 INSULATING BARRIERS 61

33 SAFETY EARTH GROUNDING 62
33.1 PARTS TO BE CONNECTED TO SAFETY EARTH GROUND 62
33.2 SAFETY EARTH GROUNDING MEANS 63
33.3 SAFETY EARTH GROUNDING TERMINALS 64
33.4 SAFETY EARTH GROUND PATH REQUIREMENTS 65

34 LEAKAGE CURRENT 65
34.1 SERVICE PROTECTION 66
34.1.1 Primary Circuits and Shock Hazards 66
34.1.2 Moving Parts 66
34.1.3 Conductive Parts 66
34.1.4 Hot Surfaces 67

35 COMPONENTS AND APPLICATIONS 67
35.1 CATHODE RAY TUBES (CRTs) 69

36 MARKINGS AND INSTRUCTIONS 69
36.1 LANGUAGES, LABEL QUALITY, LABEL COLOR 69
36.2 PRODUCT RECALL INFORMATION 69
36.3 SEPARATE INSTRUCTIONS AND MANUAL 69
36.3.1 Installation and Power 70
36.3.2 Cathode Ray Tubes 70
36.3.3 Accessory Equipment 71
36.3.4 High Leakage Current 71

37 MARKING PERTAINING TO ENCLOSURES 71
37.1 NAMEPLATE REQUIREMENTS 71
37.2 CAUTIONARY MARKINGS 73

INDEX

FIGURES

1	Overlap Between Flat Cover and Box Flange and at Corner or Box Seam	6
2	Protective Pan	9
3	Cathode Ray Tube Enclosure Opening	12
4	Test Finger	30

TABLES

1	Thickness of Sheet Metal for Enclosures - Carbon Steel or Stainless Steel	3
2	Thickness of Sheet Metal for Enclosures - Copper or Brass	4
3	Acceptable Bottom Panels	8
4	Enclosure Tests	19
5	Size of Bonding Conductor	27
6	Duration of Current Flow for Bonding-Conductor Test	27
7	RF Emission Limits	37
8	Minimum Acceptable Spacings - UL/IEC	55
9	Minimum Acceptable Spacings - CSA	56
10	Minimum Acceptable Spacings for Products with Known and Controlled Transient Voltages (UL/IEC)	58
11	Conductor Spacings for Printed Circuit Boards (CSA)	60
12	Power Supply Primary-Circuit Spacings Other Than At Field-Wiring Terminals	60
13	Power Supply Primary-Circuit Spacings Field-Wiring Terminals	61
14	Dimensions of Bushings	61
15	Maximum Leakage Current	65
16	Purchased Components	68

DEC STD 080-1 DIGITAL PRODUCT SAFETY INDUSTRIAL CONTROL EQUIPMENT - DESIGN CRITERIA

EQUIPMENT that meets the requirements of CSA 22.2 No. 220 may be used as component parts of EQUIPMENT located in a controlled environment without further investigation. See subhead 1.37.1, Nameplate Requirements, item (e) for labeling requirements.

Parts or components mounted in a UL Type 12 ENCLOSURE which meet DEC STD 119 are acceptable without further investigation.

NOTE

When a value for measurement is given in this standard it is followed by an equivalent value in other units in parentheses. The second value may be only approximate. The first stated value is the requirement.

Unless indicated otherwise, all voltages and current values mentioned in this standard are root-mean-square (rms).

1 ENCLOSURES

1.1 GENERAL

An ENCLOSURE for electrical EQUIPMENT shall be constructed and assembled so that it will have the strength and rigidity necessary to resist the abuse to which it may be subjected, without increasing the fire and accident hazards due to total or partial collapse with resulting reduction of spacings, loosening or displacing of parts or other serious defects.

An ENCLOSURE shall be constructed so as to reduce the risk of unintentional contact with enclosed electronic devices and to provide internal devices with protection from specified external conditions.

1.2 CAST METAL

A cast metal ENCLOSURE shall be at least 1/8 inch (3.2 mm) thick at every point; more than 1/8 inch (3.2 mm) thick at reinforcing ribs and door edges; and at least 1/4 inch (6.4 mm) thick at tapped holes for conduit.

Exception: Other than at plain or threaded CONDUIT holes, malleable iron and die-cast or permanent mold cast brass, bronze, or zinc shall be:

a. At least 3/32 inch (2.4 mm) for die-cast and 1/8 inch (3.2 mm) (for others) thick for an area greater than 24 square inches (155 cm^2) or having any dimension more than 152 mm (6 inches) and

b. At least 1/16 inch (1.6 mm) thick for an area of 24 square inches (155 cm^2) or less having no dimension greater than 6 inches (152 mm). The area considered may be bounded by reinforcing ribs subdividing a larger area.

1.3 SHEET METAL

a. The thickness of a sheet metal ENCLOSURE shall not be less than specified in Tables 1 and 2, except for points to which a wiring system is to be connected, uncoated steel shall be at least 0.032 inch (0.81 mm) thick, zinc-coated steel at least 0.034 inch (0.86 mm) thick, and nonferrous metal at least 0.045 inch (1.14 mm) thick.

   Exception: ENCLOSURE thickness at points other than where a wiring system is to be connected need not comply with these thickness requirements if the ENCLOSURE complies with the requirements in *DEC STD 080-2 Test Methods for Compression and Deflection*.

b. Tables 1 and 2 are based on a uniform deflection of the ENCLOSURE for any given load concentrated at the center of surface regardless of metal thickness.

c. With reference to Tables 1 and 2, a supporting frame is a structure of angle, or channel, or folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimension as the ENCLOSURE surface. It also has sufficient torsional rigidity to resist the bending moments that may be applied by the ENCLOSURE surface when it is deflected. A structure that is as rigid as one built with a frame of angles or channels is considered to have equivalent reinforcing.

   Constructions considered to be without supporting frame include:

   1. A single sheet with single formed flanges-formed edges
   2. A single sheet that is corrugated or ribbed
   3. An ENCLOSURE surface loosely attached to a frame, for example with spring clips
   4. An ENCLOSURE surface having an unsupported edge

Table 1: Thickness of Sheet Metal for Enclosures - Carbon Steel or Stainless Steel

Without Supporting Frame (a)		With Supporting Frame or Equivalent Reinforcement (a)		Minimum Acceptable Thickness Inches (mm)	
Maximum Width (b)	Maximum Length (c)	Maximum Width (b)	Maximum Length (c)	Uncoated	Metal Coated
inches cm	inches cm	inches cm	inches cm	inches mm	inches mm
4.0 10.2	Not limited	6.25 15.9	Not limited	0.020(d) 0.51	0.023(d) 0.58
4.75 12.1	5.75 14.6	6.75 17.1	8.25 21.0		
6.0 15.2	Not limited	9.5 24.1	Not limited	0.026(d) 0.66	0.029(d) 0.74
7.0 17.8	8.75 22.2	10.0 25.4	12.5 31.8		
8.0 20.3	Not limited	12.0 30.5	Not limited	0.032 0.81	0.034 0.86
9.0 22.9	11.5 29.2	13.0 33.0	16.0 40.6		
12.5 31.8	Not limited	19.5 49.5	Not limited	0.042 1.07	0.045 1.14
14.0 35.6	18.0 45.7	21.0 53.3	25.0 63.5		
18.0 45.7	Not limited	27.0 68.6	Not limited	0.053 1.35	0.056 1.42
20.0 50.8	25.0 63.5	29.0 73.7	36.0 91.4		
22.0 55.9	Not limited	33.0 83.8	Not limited	0.060 1.52	0.063 1.60
25.0 63.5	31.0 78.7	35.0 88.9	43.0 109.2		
25.0 63.5	Not limited	39.0 99.1	Not limited	0.067 1.70	0.070 1.78
29.0 73.7	36.0 91.4	41.0 104.1	51.0 129.5		
33.0 83.8	Not limited	51.0 129.5	Not limited	0.080 2.03	0.084 2.13
35.0 88.9	47.0 119.4	54.0 137.2	66.0 167.6		
42.0 106.7	Not limited	64.0 162.6	Not limited	0.093 2.36	0.097 2.46
47.0 119.4	59.0 149.9	68.0 172.7	84.0 213.4		
52.0 132.1	Not limited	80.0 203.2	Not limited	0.108 2.74	0.111 2.82
60.0 152.4	74.0 188.0	84.0 213.4	103.0 261.6		
63.0 160.0	Not limited	97.0 246.4	Not limited	0.123 3.12	0.126 3.20
73.0 185.4	90.0 228.6	103.0 261.6	127.0 322.6		

a. See subhead 1.1.3, Sheet Metal, item (c).
b. The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.
c. "Not limited" applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.
d. Sheet steel for an enclosure intended for outdoor use - raintight or rainproof - shall not be less than 0.034 inch (0.86 mm) thick if zinc-coated and not less than 0.032 inch (0.81 mm) thick if uncoated.

Table 2: Thickness of Sheet Metal for Enclosures - Copper or Brass

Without Supporting Frame (a)		With Supporting Frame or Equivalent Reinforcement (a)		
Maximum Width (b)	Maximum Length (c)	Maximum Width (b)	Maximum Length (c)	Minimum Acceptable Thickness
inches cm	inches cm	inches cm	inches cm	inches mm
3.0 7.6	Not limited	7.0 17.8	Not limited	
3.5 8.9	4.0 10.2	8.5 21.6	9.5 24.1	0.023 (d) 0.58
4.0 10.2	Not limited	10.0 25.4	Not limited	
5.0 12.7	6.0 15.2	10.5 26.7	13.5 34.3	0.029 0.74
6.0 15.2	Not limited	14.0 35.6	Not limited	
6.5 16.5	8.0 20.3	15.0 38.1	18.0 45.7	0.036 0.91
8.0 20.3	Not limited	19.0 48.3	Not limited	
9.5 24.1	11.5 29.2	21.0 53.3	25.0 63.5	0.045 1.14
12.0 30.5	Not limited	28.0 71.1	Not limited	
14.0 35.6	16.0 40.6	30.0 76.2	37.0 94.0	0.058 1.47
18.0 45.7	Not limited	42.0 106.7	Not limited	
20.0 50.8	25.0 63.4	45.0 114.3	55.0 139.7	0.075 1.91
25.0 63.5	Not limited	60.0 152.4	Not limited	
29.0 73.7	36.0 91.4	64.0 162.6	78.0 198.1	0.095 2.41
37.0 94.0	Not limited	87.0 221.0	Not limited	
42.0 106.7	53.0 134.6	93.0 236.2	114.0 289.6	0.122 3.10
52.0 132.1	Not limited	123.0 312.4	Not limited	
60.0 152.4	74.0 188.0	130.0 330.2	160.0 406.4	0.153 3.89

a. See subhead 1.1.3, Sheet Metal, item (c).
b. The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.
c. "Not limited" applies if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.
d. Sheet copper or brass for an enclosure intended for outdoor use, raintight or rainproof, shall not be less than 0.029 inch (0.74 mm) thick.

1.4 POLYMERIC MATERIAL

ENCLOSURES made of insulating materials shall give strength and protection at least equivalent to that provided by metal of thickness specified in Tables 1 and 2.

A polymeric electrical ENCLOSURE or a polymeric part of an electrical ENCLOSURE shall comply with the applicable requirements in the *Standard for Polymeric Materials - Use in Electrical Equipment Evaluations*, UL 746C and also with the additional requirements specified in this standard.

Exception: A polymeric plug or other closure made of a material classed in accordance with the *Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*, UL 94, and assembled to a sheet metal box to form a part of an ENCLOSURE is acceptable if closure is:

a. Not more than 1 square inch (650 mm²) in area and is:
   1. A pilot light lens classed 94V-0, 94V-1, 94V-2, or 94HB; or
   2. Classed 94V-0, 94V-1, 94V-2; or
   3. Classed 94HB and acceptable in accordance with the flammability test requirements in the *Standards for Polymeric Materials - Use in Electrical Equipment Evaluations*, UL 746C; or

b. More than 1 square inch (650 mm²) in area, classed 94V-0, 94V-1, 94V-2, or 94HB, and acceptable in accordance with the flammability and impact test requirements in the *Standard for Polymeric Materials - Use in Electrical Equipment Evaluations*, UL 746C.

A polymeric ENCLOSURE intended for connection to a rigid CONDUIT system shall comply with the test requirements described in the Polymeric Enclosure Conduit Connection Test.

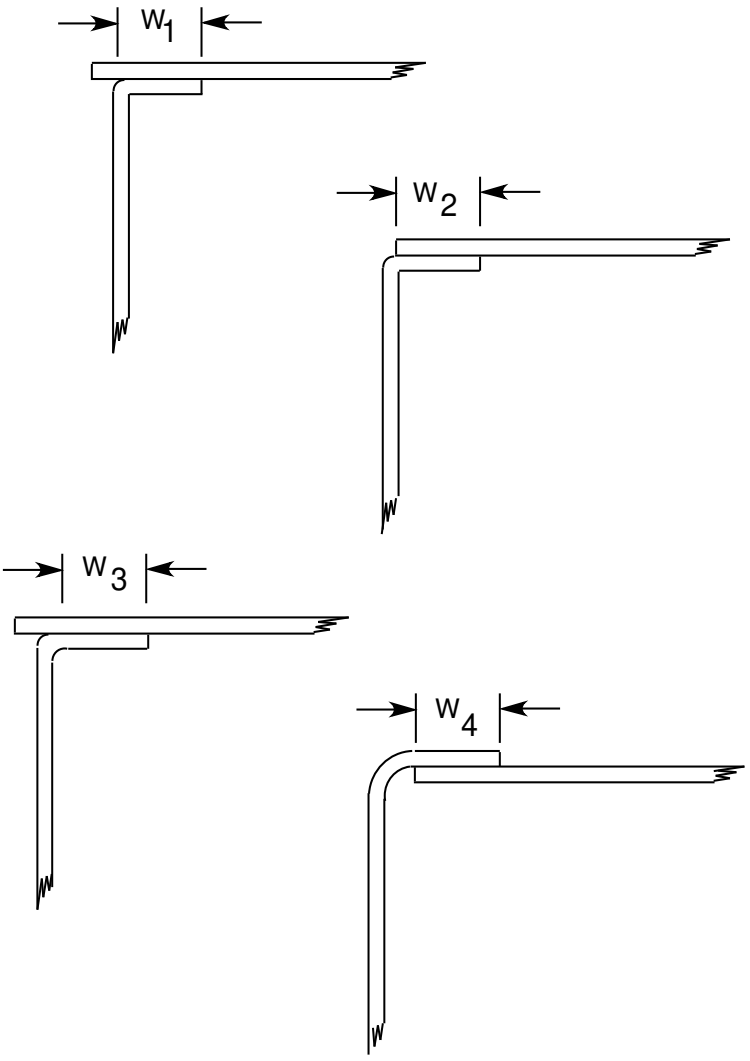
1.5 DOORS AND COVERS

ENCLOSURES and parts of ENCLOSURES such as doors and covers shall be provided with the means for securing them firmly in place. If bare parts are exposed by the opening of such doors or covers, a means requiring the use of a TOOL shall be provided to hold such doors or covers closed. The rod test specified in subhead 1.2.2, Non-Ventilation Openings is to be used to determine if bare LIVE PARTS are exposed when the door is opened. In conducting this test no internal parts including those which can be removed or opened without the use of TOOLS, are to be removed. If it is necessary to open a door, it shall be hinged or secured in an equivalent manner and all parts that present a SHOCK HAZARD are to be located or guarded so that the OPERATOR is protected from accidental contact while performing such maintenance. Any barriers or guards that are provided to comply with this requirement shall be secured in place so that the use of a TOOL or other deliberate action is required for their removal.

When a hinged door, preferably not wider than 0.9 m (36 inches), is required it shall be provided with a catch or spring latch. It is recommended that the angle of opening be at least 95 degrees. If a customer requires a color on the inside of a door different from the outside coloring, the color orange is recommended. Captive screws and bolts shall be used.

Figure 1 illustrates the method of determining the amount of overlap between a flat cover and a flanged box wall and the amount of overlap at a corner or box seam. If the radius of the flange bend is small, the flange width and overlap are considered to be W1 or W2, depending upon the actual construction, and shall be at least 1/2 inch (12.7 mm). If the radius of the flange bend is excessive or if the flat sheet radius of the flange bend is excessive or if the flat sheet is on the inside of the flange, the overlap, W3 or W4, is to be measured over only that portion where the two pieces of metal are actually in contact with each other, and shall be at least 1/2 inch (12.7 mm).

Figure 1: Overlap Between Flat Cover and Box Flange and at Corner or Box Seam



2 FRAME AND ENCLOSURE

EQUIPMENT shall have adequate mechanical strength and be so constructed as to withstand such temperatures and rough handling as may be expected in normal use.

EQUIPMENT shall be so constructed that in the event of a fire it shall not explode or collapse, nor distort so as to increase the propagation of a fire.

Where ENCLOSURES are used to limit the spread of a fire, covers shall not fall off, nor distort so as to reduce their effectiveness in enclosing a fire.

UNITS of a system that are intended to be combined in field installations to form overall unified ENCLOSURES (modular constructions) will be considered acceptable if the constructions provide complete ENCLOSURES, or the equivalent that facilitate the routing of interconnecting cables or other wiring from one UNIT of the system to another.

Such constructions shall provide complete ENCLOSURES for all wiring except power and interconnecting cables.

2.1 OPENINGS

2.1.1 Bottom

ENCLOSURES shall be designed and constructed to minimize the possibility of emission of flame, molten metal, flaming or glowing particles or flaming drops.

Except as noted below, barriers shall be provided under all internal parts to prevent materials from falling directly from the EQUIPMENT on to the supporting surface.

Compliance is checked by inspection and, where necessary, by either the Hot Flaming Oil Test (119-TM-N22) or the Molten PVC and Copper Test (119-TM-N23). See *DEC STD 119-2 Digital Product Safety - Test Procedures and Methods*.

The following constructions are acceptable and deemed to comply without test:

a. Openings of any size or number under areas that contain only PVC, TFE, PTFE, FEP, and neoprene insulated wires, cables, plugs and receptacles; and wires bearing the surface MARKING "VW-1". Refer to *UL 83, Thermoplastic Insulated Wire and Cables* for the meaning of these codes.

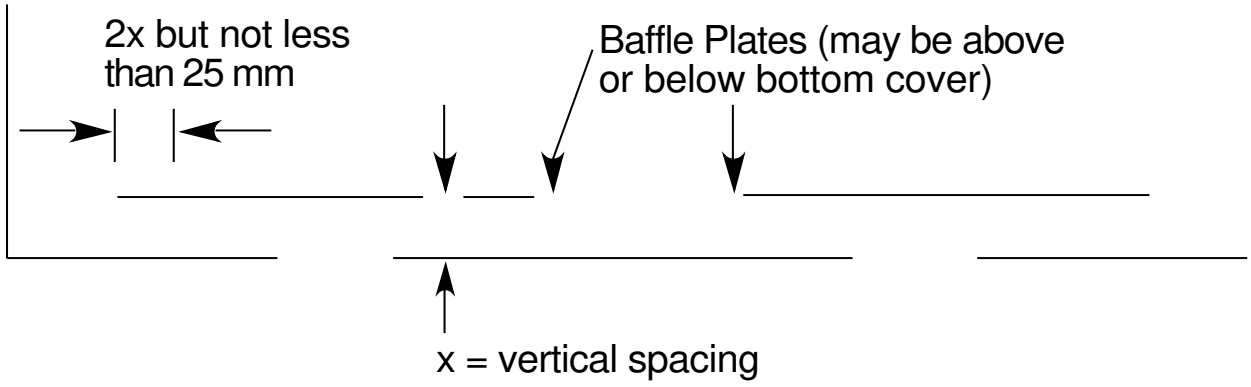
b. Openings of any size or number under impedance protected or non-automatically reset thermally protected motors, unless other parts with more stringent requirements are present.

c. Non-square openings not larger than 40 mm^2 (0.062 in^2) under COMPONENTS or parts of at least flammability classification V-1 or under COMPONENTS or parts with individual barriers. See Figure 2.

d. Galvanized steel screen or the equivalent having a 550 by 550 mesh per meter (14 by 14 mesh per inch) and wire with a diameter of 0.46 mm (0.018 inch).

e. Sheet metal bottom panels conforming with the dimensional limits of any line in Table 3.

f. Baffle plate construction as illustrated:

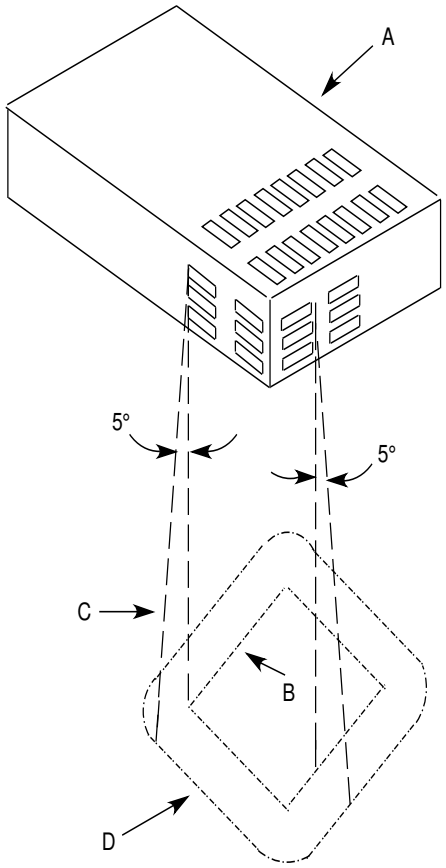


An example of an acceptable form of barrier for a partially-enclosed COMPONENT or assembly is illustrated in Figure 2.

Table 3: Acceptable Bottom Panels

Minimum Thickness		Maximum Diameter of Holes		Minimum Spacing of Holes Center-to-Center	
mm	(inch)	mm	(inch)	mm	(inch)
0.76	(0.030)	1.15	(0.045)	1.7	(0.067)
0.76	(0.030)	1.2	(0.047)	2.36	(0.093)
0.89	(0.035)	1.9	(0.075)	3.17	(0.125)
1	(0.039)	1.6	(0.063)	2.7	(0.106)
1	(0.039)	2	(0.079)	3	(0.118)

Figure 2: Protective Pan



NOTES TO FIGURE 2.

a. The entire component under which a barrier (flat or dished, with or without a lip or other raised edge) of noncombustible material is to be provided. Figure 2 is of an acceptably enclosed component with ventilating openings showing that the protective barrier is required only for those openings through which flaming parts might be emitted. If the component or assembly does not have its own noncombustible enclosure, the area to be protected is the entire area occupied by the component or assembly.

b. Projection of the outline of the area of A that needs a bottom barrier vertically downward onto the horizontal plane of the lowest point on the outer edge D of the barrier.

c. Inclined line that traces out an area D on the horizontal plane of the barrier. Moving around the perimeter of the area B that needs a bottom barrier, this line projects at a 30-degree angle from the line extending vertically at every point around the perimeter of A and is oriented to trace out the largest area, except that the angle may be less than 5 degrees if the barrier or side panel of noncombustible material or if the horizontal extension of the barrier B to D exceeds 6 inches (152 mm).

d. Minimum outline of the barrier, except that the extension B to D need not exceed 6 inches (152 mm) (flat or dished, with or without a lip or other raised edge). The bottom of the barrier may be flat or formed in any manner provided that every point of area D is at or below the lowest point on the outer edge of the barrier.

Barrier material shall be classified as other ENCLOSURE materials.

Desk top EQUIPMENT, bottom panels or barriers as described above may be flammable provided that they have a flammability classification of at least V-2, and meet the Mechanical Construction requirements, DEC STD 119-1, subhead 1.1.5, Mechanical Construction, for ENCLOSURES protecting against contact with parts at hazardous voltages.

Movable EQUIPMENT shall be constructed so as to prevent the penetration from the table or floor of any objects which might impair the safety of the machine.

All hazardous LIVE PARTS shall be at least 6 mm (0.236 inch) distance from the supporting surface, measured vertically through any openings.

Compliance is checked by inspection and measurement.

Machines equipped with legs, feet or other supporting devices are deemed to comply with this requirement if the supporting devices have a length of at least 10 mm (0.39 inches) for machines intended to be placed on a table, or 20 mm (0.78 inches) for machines intended to be placed on the floor.

Floor-standing EQUIPMENT shall be so constructed that in the event of liquid spillage onto the supporting surface from the EQUIPMENT or from an external source, no electrical SHOCK HAZARDS results. If there is an opening in the base, all LIVE PARTS shall be at least 6 mm (0.236 inch) vertical distance from the supporting surface.

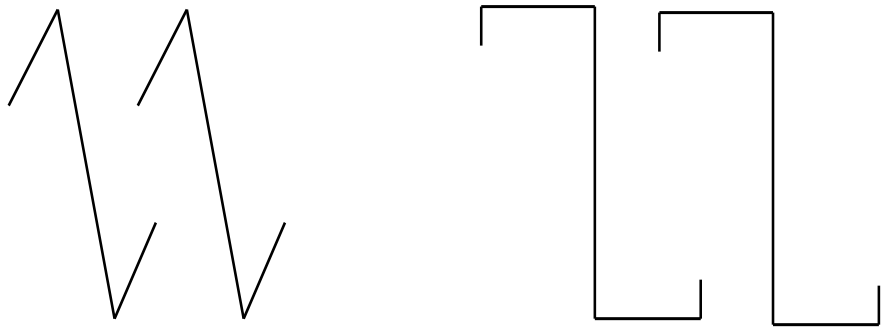
Compliance is checked by inspection and measurement.

2.1.2 Top

There shall be no openings directly over parts at hazardous voltages in the top of the ENCLOSURE of a floor-mounted UNIT of 1200 mm (47.25 inches) or less in height. Compliance is checked by inspection.

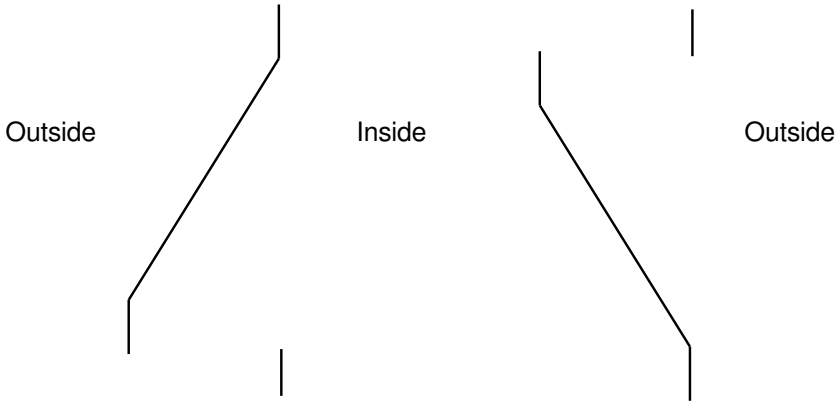
Openings directly over parts at hazardous voltages in the top of the ENCLOSURE of a UNIT more than 1200 mm (47.25 inches) high or of a desk top UNIT shall not exceed 4.7 mm (0.185 inch) in any dimension unless the configuration is such that straight access to parts at hazardous voltages is prevented. Compliance is checked by inspection.

Below are cross-sections of top cover designs preventing straight access.



2.1.3 Sides

In the side of the ENCLOSURE, openings shall be so located and of such a size that accidental entry of a foreign object likely to be present and likely to cause a hazard shall be prevented. The same size hole openings that meet the top opening requirements are acceptable. Louvers may be used if shaped to deflect falling objects outwards.

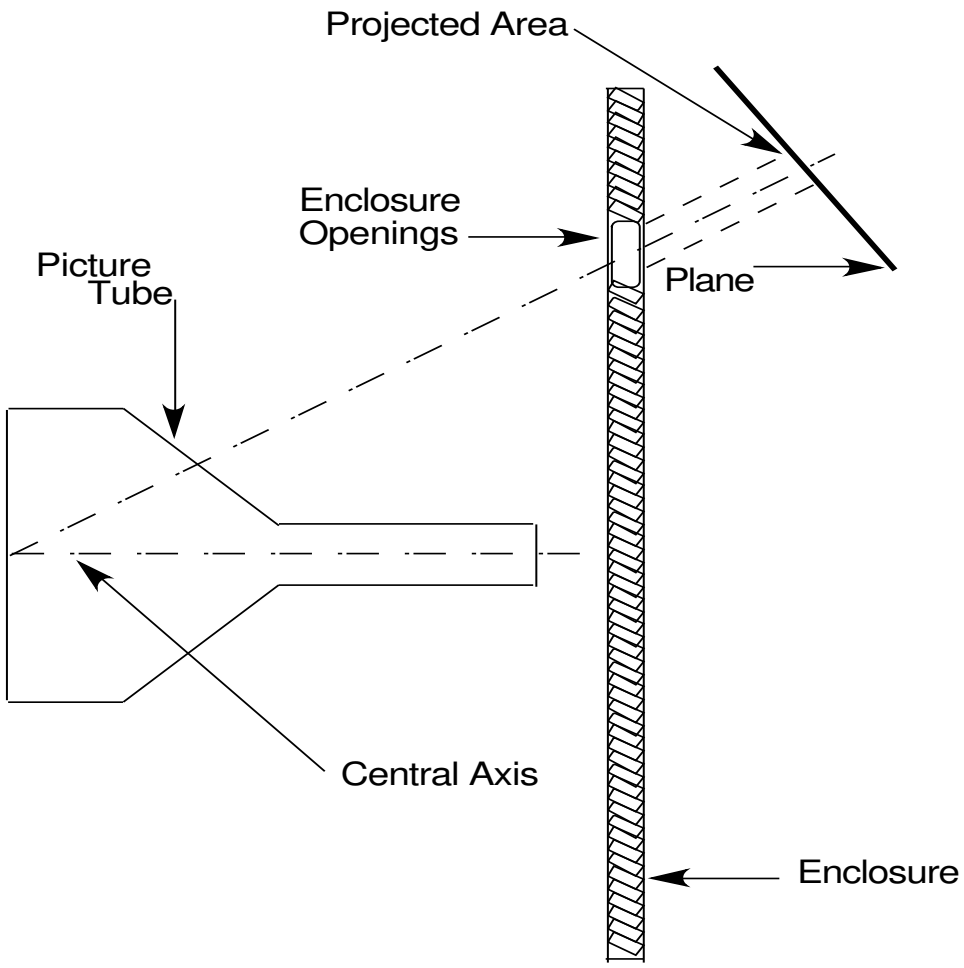


Compliance is checked by inspection.

2.1.4 Cathode Ray Tube (CRT) Enclosures

To reduce the risk of injury that may result from implosion of a cathode ray tube (CRT) having a minimum diameter of 152 mm (6 inches), or equivalent face area, the projected area of an opening in the top, back, sides, or front of the ENCLOSURE onto a plane perpendicular to a line passing through the center of the opening and any point on the central axis of the bulb section of the picture tube shall not exceed 129 sq mm (2 sq inches), unless the minor dimension of the projected area is not more than 9.5 mm (3/8 inch). The CRT ENCLOSURE opening is illustrated in Figure 3.

Figure 3: Cathode Ray Tube Enclosure Opening



2.2 NON-VENTILATION OPENINGS

These openings shall not permit the entrance of a 0.125 inch (3.18 mm) diameter rod. If the distance between the opening and the nearest LIVE PART is more than 4 inches (102 mm), the opening shall not permit the entrance of a 0.500 inch (12.70 mm) diameter rod.

2.3 VENTILATION OPENINGS

A ventilation opening in the top of the ENCLOSURE shall be covered by a hood or protective shield spaced above the opening to prevent the entry of water or objects falling vertically downward.

Any ventilation opening in a UL Type 1, 2, or 3R ENCLOSURE shall be such size or shape that no opening will permit the passing of a rod having a diameter of 0.500 inch (12.7 mm).

Exception: If the distance between any uninsulated LIVE PART and the opening is more than 4 inches (102 mm) the opening shall not permit passage of a rod having a diameter of 0.750 inch (19.05 mm).

A louver shall not be more than 12 inches (305 mm) long.

The area of an opening covered by a louver, a perforated or an expanded-metal mesh panel that is thinner than the ENCLOSURE shall not exceed 200 square inches (0.129 m^2).

The diameter of the wires of a screen shall be at least 0.051 inch (1.30 mm) if the screen openings are 0.500 square inch (32.3 mm^2) or less in area, and shall be at least 0.081 inch (2.06 mm) for larger screen openings.

Perforated sheet steel and sheet steel employed for expanded-metal mesh shall be at least 0.042 inch (1.07 mm) thick if uncoated and at least 0.045 inch (1.14 mm) thick if zinc-coated for mesh openings or perforations 0.500 square inch (3.2 cm^2) or less in area, and shall be at least 0.080 inch (2.03 mm) thick if uncoated, and at least 0.084 inch (2.13 mm) thick, if zinc-coated, for larger openings.

Exception: In small devices where the indentation of a guard or ENCLOSURE will not alter the clearance between uninsulated, movable LIVE PARTS and grounded metal so as to adversely affect the performance or reduce the spacings below the minimum values specified in Table 8, Minimum Acceptable Spacings. Expanded-metal mesh of uncoated steel not less than 0.020 inch (0.51 mm) thick and zinc-coated steel not less than 0.023 inch (0.58 mm) thick may be used, provided that:

a. The exposed mesh on any one side surface of the device so protected has an area not more than 72 square inches (464 cm^2) and has no dimension greater than 12 inches (304.8 mm), or

b. The width of the openings so protected is not greater than 3.50 inches (88.9 mm)

2.3.1 Ventilation Openings Using a Fuse or Circuit Breakers

A ventilation opening in an ENCLOSURE that contains a fuse or a circuit breaker shall comply with the following requirements.

a. The fuse shall be of a type that has been shown by test to clear the circuit under fuse-interrupting and short-circuit tests without:
    1. Ignition of the cotton test indicator,
    2. Emission of molten metal,
    3. Charring of the fuse casing or fuse ENCLOSURE, or
    4. Melting of external soldering connections, or

b. The opening shall be so constructed and located to not be exposed to flame or molten metal emitted during:
    1. Arcing normally encountered in the operation of power-circuit switches, CIRCUIT BREAKERS, or fuses of other than the type covered above; or
    2. Burnout of current elements from overload and short-circuit tests of sufficient magnitude to produce COMPONENT malfunction or breakdown.

2.3.2 Barriers Used With Ventilation Openings

a. Unless a ventilation opening is located at least 12 inches (305 mm) from an arcing part, the requirements under subhead 1.3.3.1, Ventilation Openings Using a Fuse or Circuit Breaker, will necessitate the inter-position of a barrier of metal or other material between the ventilating opening and a possible source of arcing, such as a switch, a fuse, the vent openings of a CIRCUIT BREAKER, and the like.

b. The barrier shall be of such dimensions and so located that any straight line drawn from any arcing part past the edge of the barrier intersects a point in the ventilating opening plane that is at least 0.25 inch (6.4 mm) outside of the edge of the ventilation opening.

c. A sheet metal barrier shall be at least 0.053 inch (1.35 mm) thick if uncoated steel, or 0.056 inch (1.42 mm) thick if zinc-coated.

   Exception: A metal barrier may be of a thinner metal provided its strength and rigidity are not less than that of a flat sheet of steel having the same dimensions as the barrier and of the specified thickness.

d. A nonmetallic barrier shall be at least 0.250 inch (6.45 mm) thick and shall be supported to give the necessary strength and rigidity of a comparable metal material.

   Exception: A nonmetallic material may be less than 0.250 inch (6.4 mm) thick if the barrier is so constructed so that it will not be subjected to mechanical damage during installation and supported so that it will have the necessary mechanical strength and rigidity.

2.3.3 Forced Ventilation

If ventilation is fan forced, that is, ventilation is accomplished by one or more blowers within the ENCLOSURE that provide a positive intake and exhaust, the ventilation openings shall comply with the following paragraph in addition to the requirements under subhead 1.3.3.1, Ventilation Openings.

If OPERATOR controls are provided on the ENCLOSURE, the air outlet shall not direct exhaust air at the area occupied by the OPERATOR of the EQUIPMENT.

2.4 WINDOWS

2.4.1 Observation Windows

Glass covering an observation opening and forming a part of the ENCLOSURE shall be reliably secured in such a manner that it cannot be readily displaced in service and shall provide mechanical protection of the enclosed parts. Glass for an opening not more than 4 inches (102 mm) in any dimension, shall not be less than 0.055 inch (1.40 mm) thick; and glass for an opening having no dimension greater than 305 mm (12 inches) shall not be less than 0.115 inch (2.92 mm) thick. Glass used to cover a large opening shall have the necessary mechanical strength and shall otherwise be acceptable for the purpose.

Materials other than glass shall comply with the flammability and mechanical requirements as an ENCLOSURE.

2.4.2 Mechanical Windows

Provision shall be made for mounting EQUIPMENT securely in position. Fastening means shall be independent of those securing COMPONENT parts of the EQUIPMENT to the frame, base, or panel.

Electrical COMPONENTS intended to be attached to the EQUIPMENT structure shall be fastened securely and rigidly and shall be prevented from turning by means other than friction between surfaces, if turning would result in reduction of spacings below those specified under subhead 1.31, Spacings, item (e).

A lock washer is not considered acceptable as a means to prevent the turning of a stem-mounted rotary switch.

Electrical EQUIPMENT shall be located or enclosed so that suitable protection will be provided against accidental contact with bare LIVE PARTS; except that the terminal parts of extra-low voltage circuits and bare LIVE PARTS of UNITS for rack mounting and UNITS intended to be installed in other EQUIPMENT need not be enclosed.

2.5 GASKETS

Gasket material must retain its effectiveness in service and shall not lose resilience or become sticky at any temperature likely to be encountered. Gaskets which in use are liable to be destroyed by oil, grease or vermin are not acceptable. In CSA Enclosures 3 and 4 gaskets must withstand continued exposure to moisture.

Gaskets shall be mounted so that they are not liable to be readily damaged and shall be securely held in position. The use of a cement as the sole means of securing a gasket in position shall be made the subject of investigation. The adhesive properties of such a cement shall remain effective over the expected life of the gasket.

Gaskets which are unprotected from the outside by a lip or flange shall be set back from the edge of the cover or ENCLOSURE at least the thickness of the gasket, but not less than 0.10 inch (2.5 mm), or suitable provision is made for prying off the cover.

3 SPECIFIC ENCLOSURES

An ENCLOSURE shall comply with the construction requirements applicable to an ENCLOSURE of the type number or numbers with which it is marked.

A watertight connection at a CONDUIT entrance shall be a CONDUIT hub or the equivalent, such as a knockout or fitting, located so that when CONDUIT is connected and the ENCLOSURE is mounted in the intended manner, the ENCLOSURE is found to be acceptable when subjected to the test specified in Table 4. If a supplementary housing is added to make the EQUIPMENT suitable for outdoor use, the effect on the temperature rise is to be investigated.

3.1 UL TYPE 1, IEC CLASS IP2X

ENCLOSURES shall comply with the supply connection requirements under subhead 1.22.1, Permanently Connected Equipment, item (a).

3.2 UL TYPE 2, IEC CLASS IP22, CSA ENCLOSURE 2

ENCLOSURES shall have provisions for drainage of water and shall have a threaded CONDUIT hub or the equivalent for the connection of CONDUIT at the top or side walls.

Exception No. 1: If the CONDUIT connection opening is wholly below the lowest terminal lug or other LIVE PART intended for use within the ENCLOSURE, a threaded CONDUIT hub or the equivalent need not be provided. A UL Type 2 ENCLOSURE that has knockouts for CONDUIT in the sides or back of the ENCLOSURE and in which the EQUIPMENT to be installed is not known shall be marked to indicate the area in which live parts are to be installed. See *DEC STD 178-3 Digital Marking Requirements for Completed Products Intended to be Sold*, heading 11, Labels for Specific Conditions.

Exception No. 2: UL only - Provisions for a CONDUIT hub or fitting need not be provided if information is provided as below in accordance with DEC STD 178-3 Enclosure Markings.

If the CONDUIT hubs are not provided for a UL Type 2 ENCLOSURE, the ENCLOSURE, the instruction sheet provided with the ENCLOSURE, or the the packaging carton shall be marked to indicate that raintight hubs are to be used.

3.3 UL TYPE 3, IEC CLASS IP24

ENCLOSURES shall have:

a. A CONDUIT hub or the equivalent for a watertight connection at CONDUIT entrances (see subhead 1.4, Specific Enclosures),

b. A mounting means external to the EQUIPMENT cavity, and

c. If a door is provided, provision for locking the door.

Exception: UL only - Provisions for a CONDUIT hub or fitting are not required if information is provided as below in accordance with DEC STD 178-3 Enclosure Markings.

If the conduit hubs are not provided for a UL Type 3 ENCLOSURE, the ENCLOSURE, the instruction sheet provided with the ENCLOSURE, or the packaging carton shall be marked to indicate that raintight hubs are to be used.

3.4 UL TYPE 3R, IEC CLASS IP23, CSA ENCLOSURE 3

ENCLOSURES shall have:

a. A CONDUIT hub or the equivalent for a watertight connection at CONDUIT entrances. See subhead 1.4, Specific Enclosures.

b. Provision for drainage of water, and

c. If a door is provided, provision for locking the door.

Exception No. 1: If the CONDUIT connection opening is wholly below the lowest terminal lug or other LIVE PART intended for use within the ENCLOSURE, a threaded CONDUIT hub or the equivalent need not be provided. A UL Type 3R Enclosure that has knockouts for CONDUIT in the sides or back of the ENCLOSURE and in which the equipment to be installed is not known shall be marked to indicate the area in which LIVE PARTS are to be installed. See DEC STD 178-3, heading 11, Labels for Specific Conditions.

Exception No. 2: UL only - Provisions for a CONDUIT hub or fitting need not be provided if information is provided in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions.

If the CONDUIT hubs are not provided for a UL Type 3R Enclosure, the ENCLOSURE, the instruction sheet provided with the ENCLOSURE, or the packaging carton shall be marked to indicate that raintight hubs are to be used.

3.5 UL TYPE 3S

ENCLOSURES shall have:

a. A CONDUIT hub or the equivalent for a watertight connection at CONDUIT entrances. See subhead 1.4, Specific Enclosures,

b. A mounting means external to the EQUIPMENT cavity,

c. If a door is provided, provision for locking the door, and

d. Operating mechanisms that will support the additional weight of ice and withstand removal of ice by a TOOL to gain access to the interior of the ENCLOSURE. Auxiliary means may be provided to break the ice and to permit operation of external mechanisms.

Exception: UL only - Provisions for a CONDUIT hub or fitting need not be provided as below if information is provided in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions.

If the CONDUIT hubs are not provided for a UL Type 3S Enclosure, the ENCLOSURE, the instruction sheet provided with the ENCLOSURE, or the packaging carton shall be marked to indicate that raintight hubs are to be used.

3.6 UL TYPES 4, 4X, 6, 6P, and 11, IEC IP25, CSA ENCLOSURE 4

ENCLOSURES shall have a CONDUIT hub or the equivalent mounted in place to provide a watertight connection at CONDUIT entrances and shall have mounting means external to the EQUIPMENT cavity. See DEC STD 178-3, heading 11, Labels for Specific Conditions.

Exception No. 1: The watertight CONDUIT connection provision need not be mounted in place if information is provided in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions.

Exception No. 2: A hub fitting need not be provided or installed if instructions are provided as specified in DEC STD 178-3, heading 11, Labels for Specific Conditions.

3.7 UL TYPE 12, IEC IP65, CSA ENCLOSURE 5

ENCLOSURES shall have no CONDUIT knockout or opening and no hole through the ENCLOSURE other than a hole for a mechanism, or the equivalent that is provided with an oil resistant gasket. Each door shall be provided with an oil-resistant gasket. Temperature inside the ENCLOSURE shall not be affected.

3.8 UL TYPE 13, IEC IP54

ENCLOSURES shall have oil-resistant gaskets and, if intended for wall or machine mounting, shall have a mounting means external to the EQUIPMENT cavity. There shall be no CONDUIT knockout or unsealed opening providing access to the EQUIPMENT cavity. All CONDUIT openings shall have provision for oil-tight connections.

4 ENCLOSURE PERFORMANCE

The performance requirements of an ENCLOSURE are determined by the specific environmental type designation and other features such as gasketing or use of materials thinner than required by Table 1 or 2.

A gasket of an elastomeric or thermoplastic material employed to comply with the requirements for a UL Type 2, 3, 3R, 3S, 4, 4X, 6, 6P, 11, 12, 12K, or 13 Enclosure shall be resistant to aging. See DEC STD 080-2, Gasket Test.

An ENCLOSURE shall be subjected to the tests specified in Table 4 applicable to an ENCLOSURE of the type number or numbers with which it is marked.

A COMPONENT, such as a pilot light, a disconnect mechanism, a push-button switch, or the like, intended for use with a type designated environmental ENCLOSURE, may be acceptable for use with that ENCLOSURE if the following conditions are met:

a. The COMPONENT has been installed on a representative ENCLOSURE and evaluated for its intended use.

b. All hardware, gaskets, or other parts needed to complete the installation are provided with the COMPONENT.

   Exception: Hardware, gaskets, or other parts, need not be provided with the COMPONENT if they are available from the COMPONENT manufacturer in the form of a kit and the COMPONENT is marked as specified in DEC STD 178-3, heading 11, Labels for Specific Conditions.

c. Installation instructions including such information as mounting hole location, opening configuration, and the like are provided either on the COMPONENT, in the COMPONENT package, or on a stuffer sheet.

d. The COMPONENT, its carton, or accompanying instruction sheet is marked in accordance with the requirement in DEC STD 178-3, heading 11, Labels for Specific Conditions.

An external operating mechanism or device, such as those for a disconnect, a pilot device, or a resetting operation, mounted on or through an ENCLOSURE shall withstand the tests specified for the ENCLOSURE unless otherwise indicated.

NOTES TO TABLE 4

Table 4 is based on the UL enclosure type requirements. The UL type enclosure requirements generally meet or exceed the test requirements for the associated IEC classifications. For this reason this table cannot be used to convert from IEC classification to UL types.

IEC enclosure designations do not specify degrees of protection against mechanical damage of equipment nor conditions such as moisture produced by condensation, corrosive vapors, fungus, or vermin. UL and CSA standards do test for environmental conditions such as corrosion, rust, icing, oil, and coolants. For this reason, and because the tests and evaluations for other characteristics are not identical, the IEC enclosure classification designations cannot be exactly equated with UL enclosure type numbers.

Table 4: Enclosure Tests

CSA Enclosure	IEC Classification	NEMA (UL) Type	Intended Use and Description	Requirement Qualification Tests
-	IP2X	1	Indoor use primarily to provide protection against contact with the enclosed equipment and against a limited amount of falling dirt.	Rod Entry, Rust Resistance, or Corrosion Protection
2	IP22	2	Indoor use to provide a degree of protection against windblown dust and limited amounts of falling water and dirt.	Drip, Rod Entry, Rust Resistance, or Corrosion Protection
-	IP24	3	Outdoor use to provide a degree of protection against windblown rain; undamaged by the formation of ice on the enclosure.	Atomized Water or Dust, Icing, Protection Against Corrosion, Rain
3	IP23	3R	Outdoor use to provide a degree of protection against falling rain; undamaged by the formation of ice on the enclosure.	Icing, Protection Against Corrosion, Rain, Rod Entry
-	-	3S	Outdoor use to provide a degree of protection against windblown dust, windblown rain, and sleet; external mechanisms remain operable while ice laden.	Atomized Water or Dust, Icing, Protection Against Corrosion, Rain
4	IP25	4	Either indoor or outdoor use to provide a degree of protection against falling rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure.	Hosedown, Icing, Protection Against Corrosion
-	-	4X	Either indoor or outdoor use to provide a measure of protection against falling rain, splashing water, and hose-directed water; undamaged by the formation of ice on the enclosure; resists corrosion.	Hosedown, Icing, Protection Against Corrosion
-	IPX7	6	Indoor or outdoor use to provide protection against entry of water in temporary, limited submersion, undamaged by the formation of ice on the enclosure.	Icing, Protection Against Corrosion, Submersion

Table 4 (Cont.): Enclosure Tests

CSA Enclosure	IEC Classification	NEMA (UL) Type	Intended Use and Description	Requirement Qualification Tests
-	IPX8	6P	Indoor and outdoor use to provide a degree of protection against the entry of water during prolonged submersion at limited depths.	Air Pressure, Icing, Protection Against Corrosion
-	-	11	Indoor use to provide by oil immersion a degree of protection of the enclosed equipment against the corrosion effects of corrosive liquids and gases.	Corrosion Resistance, Drip
5	IP65	12	Indoor use to provide a degree of protection against dust, dirt, fiber flyings, dripping water and external condensation of noncorrosive liquid.	Atomized Water, or Dust or Hosedown, Drip, Rust Resistance or Corrosion Protection

4.1 FLAMMABILITY

This subhead states requirements intended to minimize the risk of ignition and the spread of flame, both within the EQUIPMENT and to the outside. This is achieved by:

a. Abnormal testing, refer to DEC STD 119-1, subhead 1.1.6, Abnormal Conditions;

b. Avoiding high temperatures where this is possible, or by shielding or spacing flammable materials from high temperature parts, DEC STD 119-1, subhead 1.1.2.1, Ignition Sources;

c. Using materials of low flammability for internal parts.

4.1.1 Ignition Sources

Except as otherwise specified below, the parts considered likely to be a source of fire hazard shall include the following:

a. Arcing parts, such as switch or relay contacts, commutators;

b. Windings, such as in a motor, transformer, solenoid, or relay;

c. Wiring;

d. Semiconductor devices such as rectifiers, thyristors, thermistors, transistors;

e. Devices such as resistors, capacitors, inductors.

The following shall not be considered to be a source of a fire hazard:

a. The winding of a motor which is protected against overheating by means complying with CSA Standard C22.2 No. 77, *Motors with Inherent Overheating Protection*, and UL-Listed or Recognized;

b. Individual wires having INSULATION with flame retardant properties as shown by being UL and CSA approved;

c. Wiring harness consisting of wires as specified in the paragraph above, or classified as V-1 by UL and CSA;

d. Parts other than those specified in (a) through (c) above which are shown by investigation to be unlikely to produce flame or molten metal even if they are overloaded to the maximum degree permitted by the construction of the circuit in which they are connected.

The risk of ignition due to the high temperature shall be minimized by the appropriate use of COMPONENTS and by suitable construction.

Electrical COMPONENTS shall be used so that their maximum working temperature under the worst case nonfault conditions is less than that necessary to cause ignition to them, their surroundings, or lubricating materials with which they are likely to come into contact. The temperature rise limits listed in the tests in 119-TM-E4 shall not be exceeded.

Combustible materials used shall not be subject in normal use to temperatures liable to cause combustion.

COMPONENTS working at high temperatures shall be effectively shielded or separated to prevent overheating of their surrounding materials and COMPONENTS. Where it is not practical to protect COMPONENTS against overheating under fault conditions, the COMPONENTS shall be mounted on material of at least a flammability classification V-1, and shall be separated from less fire resistant material.

Compliance is checked by inspection and, where necessary, by test.

4.1.2 Internal Parts

COMPONENTS and parts of EQUIPMENT shall be so constructed or make use of materials that the propagation of fire is minimized.

Except as noted below, all materials and COMPONENTS to which the tests are applicable shall have a flammability classification of at least V-2 or HF-2.

Electrical COMPONENTS meeting flammability requirements contained in individual IEC, UL, or CSA standards pertaining to the COMPONENTS are exempted.

PRINTED-WIRING BOARDS shall be at least V-1.

A wiring harness shall comprise individual materials which are at least V-2 or which comply with the requirements of relevant IEC, UL, and CSA standards.

Alternatively, the harness when tested as an assembly shall be at least V-2. Individual clamps (not including helical wraps or other continuous forms), lacing tape, twine and cable ties need not comply.

Strain relief bushings applied over PVC-jacketed cords may be Class HB.

Meter cases (if otherwise determined to be suitable for mounting of LIVE PARTS), meter faces and indicator lamps or jewels are exempt from flammability requirements.

Air filters must meet the requirement of DEC STD 119-1 subhead 1.10.11, Air Filters.

The following requirements apply to parts which are isolated by 13 mm (0.512 inch) or more of air or by solid barrier of Class V-1 materials from electrical parts other than insulated wires and cables which, under fault conditions, are likely to produce a temperature which could cause ignition.

a. Gears, cams, belts, bearings, strain-relief applied over PVC-jacketed cords and other small parts which contribute negligible fuel to a fire are deemed compliant without test.

NOTE

Two cubic centimeters is typically accepted as a negligible volume.

b. Tubing for air or fluid systems rated not more flammable than HB.

NOTE

Consideration of the quantity used in application may dictate more stringent requirements.

c. Foamed plastic rated not more flammable than HBF, provided that they will not contribute significant amounts of fuel in application.

Oil or equivalent fluids used for lubrication or cooling or in a hydraulic system shall have a flash point of 149 °C (300 °F) or higher and the container shall be sealed construction. The system shall provide for expansion of the fluid and shall incorporate means for automatic pressure relief. This requirement does not apply to lubricating oils that are applied to points of friction in quantities which contribute negligible fuel to a fire.

Replenishable liquids such as printing inks shall have a flash point of 60 °C (140 °F) or higher and shall not be under pressure sufficient to cause the liquid to atomize except that replenishable flammable liquids having a flash point less than 60 °C (140 degrees F) and/or under sufficient pressure to cause atomization may be used, if appropriate investigation shows no liquid sprays or build-up of flammable vapor-air mixtures which could cause explosion or fire hazard are present. This investigation shall also consider the integrity of the liquid handling system.

The COMPONENT flammability requirements of this clause may be waived for the COMPONENTS within an ENCLOSURE of 0.06 cubic m (2.1 cubic ft) or less consisting totally of metal and having no ventilation openings, or within a sealed UNIT containing an inert gas.

Compliance is checked by inspection and, where necessary, by test.

4.1.3 Decorative Parts

DECORATIVE PARTS are deemed to comply without test if the material is of at least flammability Classification HB, and if the exposed surface area is less than 0.9 square meters (9.7 square feet) and no single horizontal or vertical dimension exceeds 1.8 meters (71 inches).

For outer surfaces having an exposed surface area of a single unbroken section in the same plane greater than 0.9 square meters (9.7 square feet) or a single horizontal or vertical dimension larger than 1.8 m (71 inches) the materials are deemed compliant if they show a flame spread index not exceeding 50 when tested in accordance with the Large Surface test as described in *ASTM E162, Test for Surface Flammability of Materials Using a Radiant Heat Energy Source*. (Testing is only available in a non-Digital test facility.)

The flame spread index shall be defined as the average value based on a sample of six specimens, provided that no specimen has a value greater than 75.

Specimens shall be representative of the wall section used. Surfaces having smaller surface areas than those specified are exempt from the above test. The dimensions refer to single unbroken sections. If two sides of a single piece are exposed, only the larger side is measured. Combined materials such as laminates are tested in their combined form.

4.1.4 Enclosure Material

Materials used in the construction of ENCLOSURES shall be such that the risk of ignition and the spread of fire or flames is minimized.

Compliance is checked by examination and, where necessary, by test.

Glass and ceramic which is heat-resistant, tempered, wired or laminated, and steel are deemed compliant without test.

The material shall comply with 119-TM-D14, Test Method for Flammability.

If, under normal operating conditions, any portion of the ENCLOSURE is subjected to a temperature rise of more than 40 degrees K, the material shall be conditioned as specified before test, unless aging characteristics of the material have been established.

For EQUIPMENT with a total mass not exceeding 40 lbs (18 kg) ENCLOSURE material is deemed to comply without test if the material is of at least flammability classification V-1.

NOTE

CSA requires performance of enclosure flammability tests, in 119-TM-D14, Test Method for Flammability, for equipment with a total mass not exceeding 40 lbs. (18 kg).

For outer ENCLOSURES having an exposed surface area of a single unbroken section in the same plane greater than 0.9 square meters (9.7 square feet) or a single horizontal or vertical dimension larger than 1.8 m (71 inches), the materials are deemed to comply if they show a flame spread index not exceeding 50 when tested in accordance with the Large Surface test as described in *ASTM Standard E162 Test for Surface Flammability of Materials Using a Radiant Heat Energy Source*. (Testing is only available in a non-Digital test facility.)

The flame spread index shall be defined as the average value based on a sample of six specimens provided that no specimen has a value greater than 75.

Specimens shall be representative of the wall section used. ENCLOSURES having smaller surface areas than those specified are exempt from the above test. The dimensions refer to single unbroken sections of ENCLOSURES. If two sides of a single piece are exposed, only the larger side is measured. Combined materials such as laminates are tested in their combined form.

ENCLOSURE materials shall be resistant to ignition under any abnormal condition likely to occur in the application.

Compliance is checked by the hot wire ignition test described in 119-TM-D14, Test Method for Flammability.

If uninsulated parts at hazardous voltage or parts which present an ENERGY HAZARD are located within 13 mm (0.511 inch) of a non-metallic material used as part or all of an ENCLOSURE the material, shall comply with the high current arc ignition test described in 119-TM-D14, Test Method for Flammability.

5 PROTECTION AGAINST CORROSION

Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other finish that has been found by investigation to be acceptable for this purpose. This requirement applies to all enclosing cases whether made from sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend.

Exception: This requirement does not apply to:

a. Bearings, thermal elements, sliding surfaces of a hinge, or shaft, and the like, where such protection is impractical.

b. Small parts of iron or steel, such as washers, screws, bolts, and the like, that are not current carrying, if the corrosion of such parts would not be likely to result in a risk of fire, ELECTRIC SHOCK, or injury to persons, and

c. Parts made of stainless steel that are polished or treated, if necessary.

6 OUTDOOR ENCLOSURES

Outdoor ENCLOSURES shall be protected against outdoor exposure in accordance with the following requirements:

a. Metal or printed metal shall not be used in combination such as to cause galvanic action that will adversely affect an ENCLOSURE.

b. Hinges, pins, and other attachments shall be resistant to corrosion.

c. These requirements do not include consideration of corrosion that might be caused by the exposure to the EARTH or other corrosive agents not described in applicable tests.

d. Items (e) through (n) do not apply to a part such as a decorative grill that is not required to form a part of the ENCLOSURE.

e. A nonmetallic ENCLOSURE is to be judged on the basis of the effect of exposure to water and ultraviolet light.

f. A metallic ENCLOSURE shall be protected against corrosion as specified in items (g) through (n).

g. Copper, bronze, brass containing at least 80% copper, or stainless steel may be used without additional protection against corrosion. Sheet, extruded, or die-cast zinc or another metal shall be of a grade known to be nonsusceptible to corrosion, or shall be subjected to appropriate tests, additionally protected against corrosion, or both.

h. An ENCLOSURE of cast iron or malleable iron at least 1/8 inch (3.2 mm) thick shall be protected against corrosion by:

    1. A 0.00015 inch (0.0038 mm) thick coating of zinc, or the equivalent, on the outside surface and a visible coating of such metal on the inside surface, or

    2. One coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface.

The acceptability of the paint may be determined by consideration of its composition or if necessary, by corrosion tests.

i. An ENCLOSURE of sheet steel having a thickness less than 0.126 inch (3.20 mm) if zinc-coated or 0.123 inch (3.12 mm) thick if uncoated shall be protected against corrosion by one of the following means or by other metallic or nonmetallic coatings that have been found to give equivalent protection as described in item (l).

   1. Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G90 in Table 1 of *ASTM Designation A525-73*, with not less than 40% of the zinc on any side, based on the minimum single-spot-test requirement in this ASTM designation. The weight of zinc coating may be determined by any suitable method; however in case of question, the weight of coating shall be established in accordance with the Test Method of *ASTM Designation A90-69*.
   2. A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.0155 mm) on each surface with a minimum thickness of 0.00054 inch (0.0137 mm). The thickness of the coating shall be established by the chromic-acid-dropping test described in DEC STD 080-2, Metallic Coating Thickness Determination. An annealed coating shall also comply with item (n).
   3. A zinc coating conforming with item (1) or (2) above or item (j) with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The suitability of the paint shall be determined by consideration of its composition or, if necessary, by corrosion tests.

j. An ENCLOSURE of sheet steel 0.126 inch (3.20 mm) thick or more if zinc-coated or 0.123 inch (3.12 mm) thick or more if uncoated shall be protected against corrosion by one of the following means or by other metallic or non-metallic coatings that have been shown to provide equivalent protection as described in subitem (l).

   1. Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in Table 1 of *ASTM Designation A525-73*, with not less than 40% of the zinc on any side, based on the minimum single spot-test requirement in this ASTM designation. The weight of zinc coating may be determined by any suitable method; however in case of question the weight of coating shall be established in accordance with the Test Method of *ASTM Designation A90-69*. An A60 (alloyed) coating shall also comply with item (n).
   2. A zinc coating, other than that provided on hot dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established by the chromic-acid-dropping test described in DEC STD 080-2, Metallic Coating Thickness Determinations. An annealed coating shall also comply with item (n).
   3. Two coats of an organic finish of epoxy or alkyd resin or other outdoor paint on each surface. The suitability of the paint may be determined by consideration of its composition or, if necessary, by corrosion test.
   4. Any one of the means specified in item (i).

k. Item (j) also applies to sheet steel 0.056 inch (1.42 mm) thick if zinc-coated or 0.053 inch (1.35 mm) thick if uncoated or heavier for an ENCLOSURE to be mounted within and protected from direct exposure to weather by the ENCLOSURE of other EQUIPMENT, such as an air conditioner.

l. With reference to items (i) through (k), other finishes, including paints, special metallic finishes and combinations of the two may be accepted when comparative tests with galvanized sheet steel - without annealing, wiping or other surface treatment - conforming with subitem (1) of heading 1.6, Outdoor Enclosures items (i) or (j) as applicable, indicate they provide equivalent protection. Among the factors that are taken into consideration when judging the suitability of such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light, and water.

NOTE

See Supplement B of *UL 508 for Investigation of Component Coatings*.

m. Test specimens of a finish as described in items (h) or (l), subitem (3) of item (i) or subitem (3) of item (j), if the paint is tested, are to be consistent with the finish that is to be used in production with respect to the base metal, cleaning or pretreatment method, application method, number of coats, curing method, thickness and the like.

n. A hot-dipped mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or formed after annealing and is not otherwise required to be painted shall be painted in the bent or formed area if the bending or forming process damages the zinc coating, except that such areas on the inside surface of an ENCLOSURE that are not exposed to water during the rain test need not be painted. The zinc coating is considered to be damaged if flaking or cracking of the zinc coating at the radius of the bent or formed section is visible at 25 power magnification. Simple sheared or cut edges and punched holes are not considered to be formed.

7 BONDING

a. An ENCLOSURE made of insulating material, either wholly or in part, shall have an acceptable bonding means to provide continuity of grounding between all CONDUIT openings. The bonding means may be either completely assembled on the product or provided as separate parts for field installation. See subhead 1.37.2, Cautionary Markings, item (d).

Exception: A bonding means is not required for the ENCLOSURE of a push-button station or a selector switch that is intended to be connected to a single CONDUIT. See subhead 1.37.2, Cautionary Markings, item (e).

b. The continuity of a CONDUIT system shall be provided by metal-to-metal contact not relying on a polymeric material.

c. A separate bonding conductor whether in a plastic or metal ENCLOSURE shall be copper, a copper alloy, or other material acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by galvanizing, plating, other equivalent means. A separate bonding conductor shall:

1. Be protected from mechanical damage or located within the confines of the outer ENCLOSURE or frame, and

2. Not be secured by a removable fastener used for any purpose other than bonding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

d. The size of a separate COMPONENT bonding conductor shall not be less than the applicable size specified in Table 5 or the size of the conductor supplying the COMPONENT, whichever is smaller.

Exception: A bonding conductor may be smaller than the specified size if it does not open when carrying for the time specified in Table 6, a current equal to twice the BRANCH-CIRCUIT overcurrent rating, subhead (e), but at least 40 amperes.

Table 5: Size of Bonding Conductor

Minimum Acceptable Size of Bonding Conductor (a)		
Maximum Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Amperes	Copper Wire	
	AWG	(mm^2)
20	12	(4)
30	10	(6)
40	10	(6)
60	10	(6)
100	8	(10)

(a) Or equivalent cross-sectional area.

Table 6: Duration of Current Flow for Bonding-Conductor Test

Overcurrent Device Rating	Minimum Duration of Current Flow
Amperes	Minutes
30 or less	2
31 - 60	4
61 - 100	6

8 FIELD WIRING

a. INDUSTRIAL CONTROL EQUIPMENT (other than panel-mounted EQUIPMENT, EQUIPMENT within an ENCLOSURE that is intended for rack mounting, or units intended to be used in other EQUIPMENT) shall have provision for the connection of CONDUIT to the source of supply.

b. INDUSTRIAL CONTROL EQUIPMENT intended for permanent connection to the BRANCH-CIRCUIT (mains) shall have provision for connection of one of the applicable wiring systems in accordance with the governing electrical code.

Exception: An ENCLOSURE need not have provision for the connection of a wiring system, such as a CONDUIT hub, a knockout or a fitting, if it is intended to be drilled or punched in the field to accommodate a wiring system and is provided with appropriate installation instructions.

c. When enclosed terminals (or leads) are provided for connection to Class 2 circuits, there shall be openings for the entrance of such circuits that comply with items (d) through (g) as applicable.

d. The metal to which CONDUIT or DUCT is attached, if of sheet steel, shall be not less than 1.0 mm (0.039 inch) thick and not less than 1.30 mm (0.051 inch) thick if of nonferrous metal.

e. Threaded CONDUIT openings shall comply with the requirements for threaded CONDUIT openings.

f. No conductor shall be brought through covers that must be removed to permit the connection and inspection of supply circuit conductors.

g. Unused openings shall be filled with a material that gives the same protection as the rest of the ENCLOSURE.

h. A terminal or connection box, if provided, shall comply with the applicable governing electrical code.

   If a terminal or connection box is not supplied as part of the UNIT, suitable leads shall be provided to permit connection to the supply circuit conductors in a separate terminal or connection box. These leads shall comply with the requirements of item (i) and shall extend at least 457 mm (18 inches) from the point of CONDUIT connection on the UNIT.

i. If leads are provided instead of terminals for connection to supply circuit conductors, they shall be of approved wire and not smaller than No. 18 AWG (0.75 mm^2).

j. Supply terminal blocks shall not be located on doors, access panels, or withdrawable chassis.

   ENCLOSURES shall comply with the Mechanical Test specified in DEC STD 080-2.

k. An ENCLOSURE may be supplied without CONDUIT entry, provided that it has at least one location suitable for CONDUIT entry that will provide sufficient clearance between the enclosed equipment and the ENCLOSURE for the required electrical and mechanical clearance when fitted with a CONDUIT bushing of the maximum size likely to be used.

l. When an ENCLOSURE that requires detachable CONDUIT hubs is not supplied with hubs by the ENCLOSURE manufacturer, the ENCLOSURE walls, at likely conduit locations, shall have a flat, smooth outer surface and uniform thickness to permit proper installation of approved, watertight, threaded CONDUIT hubs.

9 PROVISIONS FOR MOUNTING

Provisions shall be made for securely mounting INDUSTRIAL CONTROL EQUIPMENT to supporting surfaces. A bolt, screw, or other part used to mount a COMPONENT of the EQUIPMENT shall not be used for securing the equipment to the supporting surface.

10 INSULATING MATERIAL

Material for the support of an uninsulated LIVE PART shall be porcelain, phenolic, cold-molded composition, unfilled polycarbonate, unfilled nylon, melamine, melamine-phenolic, urea formaldehyde, or other material investigated and found acceptable for the support of an uninsulated LIVE PART in accordance with the applicable requirements in the standard, *Polymeric Materials Used in Electrical Equipment Evaluations, UL 746C*. These materials shall withstand the most severe conditions likely to be met in service.

Insulating material, including barriers between parts of opposite polarity and material that may be subject to the influence of the arc formed by the opening of a switch, shall be acceptable for the application. Materials shall not be adversely affected by the overload and endurance tests.

A printed wiring board and any coating material that is provided shall not increase the flammability of the assembly.

11 ACCESSIBILITY

Parts of a UNIT shall be located, enclosed or guarded so that anyone having access to that area will not contact uninsulated LIVE PARTS that involve a risk of ELECTRIC SHOCK or electrical energy - high current levels, or parts that might cause injury to those persons. The method of investigating openings in an ENCLOSURE or guard is as follows:

After installation or assembly of the UNIT has been completed, any part of the outer cabinet or ENCLOSURE that must be removed or opened for OPERATOR SERVICING or that can be removed or opened without the use of TOOLS shall be removed or opened before the UNIT is examined for compliance with the requirements. Parts that actuate SAFETY INTERLOCKS which meet the requirements in DEC STD 119-1, subhead 1.9.3, Interlocks, need not be removed or opened.

An opening in an ENCLOSURE, barrier or guard is acceptable if the Test Finger illustrated in Figure 4 cannot be made to touch any uninsulated LIVE PART involving ELECTRIC SHOCK or any moving part that can cause personal injury when inserted through the opening and rotated with the movable sections straight or in any possible position resulting from bending one or more sections in the same direction.

Exception: Moving parts that are necessarily exposed to perform a work function, based on consideration of the following factors with respect to intended operation or likely misuse of the EQUIPMENT:

a. Degree of exposure necessary to perform its intended function.

b. Sharpness of the moving part.

c. Likelihood of unintentional contact with the moving part.

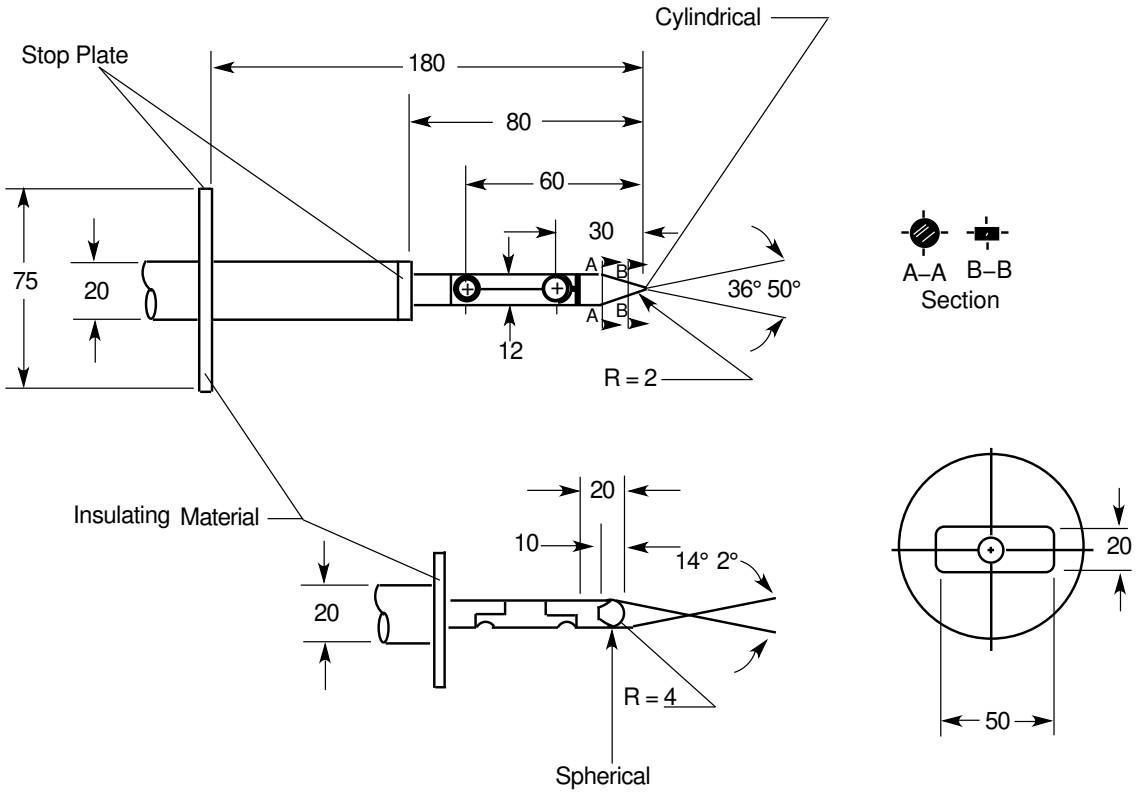
d. Speed of the moving part.

e. Likelihood that a part of the body would be endangered or that clothing would be entangled by the moving part, resulting in injury.

The Test Finger, Figure 4, is to be applied to all openings in the bottom of the ENCLOSURE. The UNIT is to be moved in whatever way necessary to make the entire bottom of the ENCLOSURE accessible for application of the probe.

Exception: For a floor standing UNIT, the probe is to be applied to all openings in the bottom of the ENCLOSURE that are accessible without tipping, turning over, or otherwise moving the UNIT from its intended installed position.

Figure 4: Test Finger



Tolerances: up to 25 mm +0.00 -0.05 mm, over 25 ± 0.2 mm, angles ± 5 minutes. All dimensions are in millimeters.

12 LIVE PARTS

A current-carrying part shall have mechanical strength and ampacity for the intended use and shall be of metal or other material that is acceptable for the application.

An uninsulated LIVE PART, including a terminal, shall be secured to its supporting surface by a method other than friction between surfaces so that it will be prevented from turning or shifting in position if such motion may result in reduction of spacings to less than those required elsewhere in this standard. The security of a contact assembly shall maintain continued alignment of contacts.

Exception: A pressure connector need not be prevented from turning provided no spacings less than those required result when the terminals are turned 30 degrees toward each other, or toward other uninsulated parts of opposite polarity, or toward grounded metal parts.

A live screwhead or nut on the underside of an insulating base shall be prevented from loosening and shall be acceptably insulated or spaced from the mounting surface. This may be accomplished by:

a. Countersinking such parts at least 1/8 inch (3.2 mm) and then covering them with a waterproof, insulating sealing compound that does not melt at a temperature of 15 °C (27 °F) higher than its normal operating temperature in the EQUIPMENT, but at least 65 °C (149 °F); or

b. Securing such parts and insulating them from the mounting surface by a barrier, or the equivalent, or by through air or over surface spacings specified elsewhere in this standard.

12.1 PRIMARY CIRCUITS

NEUTRAL shall be insulated from SAFETY EARTH GROUND and the BODY throughout the EQUIPMENT, as if it were a live phase at full phase voltage.

EQUIPMENT must be designed to meet *DEC STD 122 AC Power Line Standard: Design Requirements and Guidelines*. This will ensure that the EQUIPMENT will operate when connected to a main supply and operate over the appropriate tolerances.

Any switch, CIRCUIT BREAKER, or power relay which SERVICE PERSONNEL expect to turn off primary power shall:

a. Meet the requirements of a DISCONNECT DEVICE as described in DEC STD 119-1, subhead 1.2.2.1, Primary Power Isolation, or

b. Be labeled in the appropriate languages (See *DEC STD 064-0 Compliance With International Language Requirements* and DEC STD 178-3 Enclosure Markings), near the device indicating the proper means for disconnecting power to the EQUIPMENT.

Any switch or CIRCUIT BREAKER labeled with the circle 0 and vertical line 1 characters shall meet the requirements of a DISCONNECT DEVICE. See DEC STD 119-1, subhead 1.10.6, Switches.

12.2 PRIMARY POWER ISOLATION

A DISCONNECT DEVICE shall be provided to disconnect the EQUIPMENT from the supply for servicing.

Primary parts remaining energized when the DISCONNECT DEVICE is switched off shall be shielded to prevent accidental contact by SERVICE PERSONNEL. See subhead 1.34.1, Service Protection.

The DISCONNECT DEVICE shall have a contact separation of at least 3 mm (0.118 inch), and when incorporated in the EQUIPMENT, shall be connected as closely as practicle to the incoming supply.

Where a UNIT or group of UNITS is to be permanently connected to the supply, the DISCONNECT DEVICE shall be incorporated in the EQUIPMENT, unless the EQUIPMENT is accompanied by installation instructions stating that the DISCONNECT DEVICE shall be provided as part of the building installation in accordance with subhead 1.36.3.1, Installation and Power. External DISCONNECT DEVICES will not necessarily be supplied with the EQUIPMENT.

When used, an isolating switch shall not be fitted in a flexible cord.

The requirements for DISCONNECT DEVICES do not apply to functional switches where other means of isolation are provided. Examples of DISCONNECT DEVICES within the meaning of this subheading are:

a. An appliance coupler.

b. Isolating switches.

c. CIRCUIT BREAKERS (Requirements for DISCONNECT DEVICES should not be confused with overcurrent protection requirements.)

d. Any equivalent device offering an equal degree of safety to the above.

e. Devices complying with *IEC Publication 328 Specifications for Switches for Appliances*.

f. A plug on a POWER SUPPLY CORD provided that:

    1. The input to the UNIT does not exceed 12 amperes; and

    2. If it is motor operated, the motor has a nominal voltage rating of 120 volts or less and the locked rotor current does not exceed 43 amperes.

    3. The installation instructions comply with DEC STD 119-1, subhead 1.36.3.1, Installation and Power.

For single-phase EQUIPMENT, the DISCONNECT DEVICE shall disconnect both poles simultaneously.

For three-phase EQUIPMENT, the DISCONNECT DEVICE shall disconnect simultaneously all live poles of the supply.

If, for any reason, a DISCONNECT DEVICE interrupts the NEUTRAL it shall simultaneously interrupt all poles.

For Class I pluggable EQUIPMENT, when connecting and disconnecting the supply plug (and the appliance coupler, if any), the SAFETY EARTH GROUNDING connection shall be made earlier than the phase connection and shall disconnect later than the phase disconnection.

Where a group of UNITS having individual pluggable or permanent supply connections is interconnected in such a way that hazardous voltage or energy levels may be transmitted between UNITS, a DISCONNECT DEVICE shall be provided to disconnect hazardous parts likely to be contacted while the UNIT under consideration is being serviced, unless these parts are shielded and marked with appropriate warning labels. In addition a prominent label shall be provided on each UNIT giving adequate instructions for the removal of all power from the UNIT. For the appropriate languages, see DEC STD 178-3.

If more than one DISCONNECT DEVICE is provided on the UNIT:

a. All such devices shall be grouped together (It is not necessary that they be in the closest possible proximity to one another or that their handles be tied together.)

b. Each shall be marked to identify its function.

c. There shall be a prominent and permanent MARKING with the group to indicate which switches and controls must be off to completely disconnect the UNIT.

Exception: Receptacle outlets, controls, and other devices and parts of the UNIT that are located on the supply side of the DISCONNECT DEVICE required above or on an entirely separate circuit or circuits may remain energized if SERVICE PERSONNEL performing service functions that do not involve these devices or parts cannot contact these devices or parts. A clock or timing device on or remote from the UNIT may remain energized if there is MARKING to indicate that the clock remains energized while the UNIT is off.

If a fixed or stationary UNIT receives part or all of its power from another UNIT and the circuits involve an ELECTRIC SHOCK, either a DISCONNECT DEVICE shall be provided, or legible and durable MARKINGS shall be provided, in the appropriate languages - See *DEC STD 064-0 Compliance with International Language Requirements*, to clearly indicate the source of such power and provide instructions for operating the DISCONNECT DEVICE on the UNIT supplying such power. The DISCONNECT DEVICE may be located in an area that is not accessible to the OPERATOR.

If a switch is provided on the console and is intended to be field-connected into the emergency power-control circuit for the room, it shall be provided with an acceptable ENCLOSURE that facilitates proper connection to the field wiring necessary for the purpose.

12.2.1 Multiple Supply Sources

Only one power cord shall be provided to connect a UNIT to the PRIMARY-CIRCUIT POWER except in the following cases:

a. More than one voltage or kind of power is necessary (for example, 3-phase and 1-phase, regulated and unregulated, ac and dc).

b. The function of the UNIT is intended to be extended or reduced at a later date.

c. Redundant power-supply sources are necessary.

Separate terminals shall be provided for the different circuits.

If more than one power cord is provided on a UNIT, the design shall be such that physical disconnection of any one power-supply cord shall automatically cause de-energization of all circuits within the UNIT supplied by other cords.

Automatic de-energization may be omitted if there is a prominent MARKING at each DISCONNECT DEVICE giving adequate instructions for the removal of all power from the EQUIPMENT. See DEC STD 178-3.

In the case of power cords that remain connected, a terminal strip, any CIRCUIT BREAKER, and other parts of a UNIT on the line side of a DISCONNECT DEVICE may remain energized if SERVICE PERSONNEL performing service functions not involving these parts are protected by an ENCLOSURE or other means from unintentional contact with these parts.

The terminal configurations of the plug caps shall be different if interchange would result in a hazard.

Bare parts at FELV or hazardous voltages, such as plug contacts, when one or more connectors are disconnected must not be accessible to the OPERATOR.

12.2.2 Multi-voltage Equipment

Multi-voltage EQUIPMENT is intended to be operable from differing nominal system voltages, and to be adaptable for this purpose only under one of the following conditions:

a. When intended to be permanently wired;

b. When supplied with power cord sets unique to the intended operating voltage and with no OPERATOR accessible selector switch which when tested per 119-TM-D2, Abnormal Temperature Test, results in no hazard; or,

c. When supplied with a cord set or a POWER SUPPLY CORD and an OPERATOR accessible selector switch which when tested in accordance with 119-TM-D2, Abnormal Temperature Test, results in no hazard.

Any part intended to be part of multi-voltage EQUIPMENT to make it suitable for a particular RATED VOLTAGE shall be considered to be part of the EQUIPMENT in determining conformity to the requirements of this standard; regardless of the fact that the part may not be included with the EQUIPMENT at the time of shipment.

13 HAZARDS

13.1 CHEMICAL HAZARDS

EQUIPMENT which may generate ozone, or in which flammable liquids, flammable gases or similar hazards are present, shall be so designed that harmful effects to persons and damage to materials affecting safety is prevented.

If the malfunction of any part that contains, conducts, or otherwise contacts a liquid can result in a risk of fire, ELECTRIC SHOCK, or personal injury, or risk from electrical energy - high current levels, the part shall be resistant to the liquid involved under all conditions of use.

EQUIPMENT generating pressures in liquids or gasses shall incorporate adequate safeguards against the risk of excessive pressures.

If a product requires a liquid, powder, or other material to be replenished, removed, or replaced as part of its operation, the liquid, powder, or material:

a. If spilled, shall not create a hazard

b. During filling, emptying, storage, intended movement of the UNIT, and the like shall not cause a hazard or contribute to the occurrence of a hazard.

Replenishable liquids such as printing inks shall have a flash point of 60 °C (140 °F) or higher and shall not be under pressure sufficient to cause the liquid to atomize.

Exception: Replenishable liquids having a flash point less than 60 °C (140 °F) and/or under sufficient pressure to cause atomization may be used when it is shown that there are no liquid sprays or build-up of flammable vapor-air mixtures that can cause an explosion or fire. The integrity of the liquid handling system is also to be considered.

Oil or equivalent fluids used in a UNIT for lubrication or cooling or in a hydraulic system shall have a flash point of 148 °C (300 °F) or higher and the container shall be of sealed construction. The system shall have provision for expansion of the fluid and shall incorporate means for automatic pressure relief.

See *DEC STD 136-0 Digital Policy on Government-Regulated Materials in Digital Products* for materials which are restricted or prohibited in Digital products.

Chemicals provided by or recommended by Digital for users shall meet the following requirements:

a. They shall be packaged separately in limited quantities sufficient for one time use.

b. They shall not require the user to handle the chemical for application.

c. They shall not be flammable.

d. They shall not be applied using an aerosol propellant.

For all paints, powders, and liquid chemicals provided by Digital, there must exist an engineering and/or purchase specifications containing the following:

a. Required label contents as described in DEC STD 178-3, subhead 11.26, Chemicals.

b. The exact chemical formula and proportions of the contents.

c. Storage quantity if appropriate. Some chemicals in certain facilities can be stored only in small quantities.

d. Storage conditions if appropriate (temperature, moisture, and so forth) with special notes about hazardous results such as bursting or freezing.

e. Shelf life.

f. A copy of the Digital Material Safety Data Sheet for that product.

Departures from listing the exact chemical formula are allowed if:

a. The contents are not definable scientifically.

b. All reasonable efforts have been made to identify contents, including consultation with qualified industrial hygienists and chemists expert in quantitative analysis.

c. No reasonable identifiable alternatives are available.

Under such conditions, the resulting description must be approved as medically adequate by the Corporate Medical Director.

All chemicals to be sold by Digital must be listed in *A-SP-ELPS405-00-0, Chemical Products for Sale by Digital*. This document will be used for maintaining files of information for those whose job it is to provide emergency or routine information on hazardous substances.

The U.S. Poison Prevention Packaging Act (PPPA) requires childproof packaging for hazardous household substances and certain other substances. Contact Corporate Product Safety and Regulations for determination of the need for packaging of any particular substance. All chemicals designed for use with home computer, personal computer or terminal products will be considered by Digital as household substances for the purposes of complying with this act.

All such chemical products must have information submitted to Poisindex, the emergency poison information system used by poison control centers in the U.S.A. The forms and addresses needed are available from Corporate Product Safety and Regulations. A copy of the most recent submittal to Poisindex shall be part of the Engineering Specification for the product.

13.2 RADIATION HAZARDS

EQUIPMENT which may generate hazardous radiation or in which similar hazards are present shall be so designed that harmful effects to persons and damage to materials affecting safety is prevented.

13.2.1 X-Radiation (Ionizing Radiation)

EQUIPMENT which produces ionizing radiation shall emit no more than 2 microsieverts /hour (0.2 milliroentgens/hour). This limits potential OPERATOR exposure to less than 500 mR per year of ionizing radiation (0.2-0.25 mR/hr of a 2000 hour work year).

If shielding is required to limit the dose rate to the above level, all shielding, and any other protective devices, that can be readily removed without making the EQUIPMENT inoperative shall be clearly marked with the *DEC STD 178-5 Marking Symbology* warning symbol for radiation, together with a caution stating that a hazard from radiation will exist if the protection is removed.

Products with Cathode Ray Tubes shall be labeled in accordance with DEC STD 178-3, subhead 10.2, Cathode Ray Tubes, and have the information required by subhead 1.36.3.2, Cathode Ray Tubes, placed in associated manuals and instructions.

Products which have an anode voltage of over 20 kV and are being sold in Europe, need to be submitted to the PTB (Physikalisch-Technische Bundesanstalt) German testing agency for licensing and type tests, and are subject to production tests. Refer to EL-MF119-02, *Manufacturing Procedure for Production Testing of X-Radiation*.

Products which accept a composite video signal are considered television sets by the U.S. Bureau of Radiological Health. Contact Safety Engineering for details on reporting and production testing.

Compliance is checked by 119-TM-E10, X-Radiation (Normal Operation), and 119-TM-D12, X-Radiation (Abnormal Conditions). Additional production tests and records retention are required on an on-going basis for products containing CRTs.

13.2.2 RF Radiation (Non-ionizing Radiation)

In order to limit human exposure to RF radiation for health reasons, the product shall emit RF radiation no greater than that permitted in Table 7.

Table 7: RF Emission Limits

Frequency Range	Electric Field	Magnetic Field	Power Density
f	E^2	H^2	
MHz	V^2/m^2	A^2/m^2	mW/cm^2
0.3 - 3	400 000	2.5	100
3 - 30	4000 $(900/f^2)$	0.025 $(900/f^2)$	$900/f^2$
30 - 300	4000	0.025	1.0
300 - 1500	4000 (f/300)	0.02 (f/300)	f/300
1500 - 100000	20000	0.125	5.0

Products meeting *DEC STD 103-0 Electromagnetic Compatibility (EMC) Hardware Design Requirements* limits can be assumed to meet these requirements without further test.

14 OVERCURRENT PROTECTION FOR POWER SUPPLIES

PRIMARY CIRCUITS and secondary circuits in a UL Type 12, or CSA Enclosure 5 or equivalent ENCLOSURE having a maximum output of 100 volts RMS or less, or 200 voltamperes or less and not subject to further investigation shall be provided with overcurrent protection as indicated under subheads 1.14.1, Primary Circuits, and 1.14.2, Secondary Circuits.

14.1 POWER SUPPLY - PRIMARY CIRCUITS

a. All wiring including bus bars and interconnecting cables used in the distribution of primary electric energy within and between units of EQUIPMENT and all transformer and other loading devices connected to the primary circuit shall be protected against burnout and damage to insulation resulting from any overload or short circuit condition that can occur during operation of the EQUIPMENT.

b. The protection referred in item (a) may be obtained from overcurrent devices included as integral parts of the control EQUIPMENT or, if rated in accordance with item (d) from the protection associated with the BRANCH CIRCUIT to which the EQUIPMENT is connected.

c. Overcurrent protective devices that are provided within the EQUIPMENT and are types that are acceptable for BRANCH-CIRCUIT protection in accordance with the governing electrical code comply with the requirements in item (b). Other types of overcurrent protection devices are to be investigated to determine their acceptability for the application.

d. The ratings of an overcurrent device in series with connecting wiring shall not exceed the following:

   1. For motor loads alone: 300% of the motor full-load current observed during the maximum normal operation of the system.

   2. For resistive loads, and for combination resistive and reactive loads, with or without motor loads: 250% of the full-load current of the circuit under consideration.

e. A device providing overcurrent protection shall be of a type that is acceptable for use when supplied directly by the BRANCH CIRCUIT to which the EQUIPMENT can be connected unless additional acceptable protection is provided in the EQUIPMENT. Where a poly-phase supply is employed, all phases shall be disconnected simultaneously.

f. An overcurrent protective device shall be connected between the ungrounded BRANCH-CIRCUIT supply conductor(s) and the load.

g. If the EQUIPMENT includes one or more circuits supplying power to one or more medium-based or smaller lampholders or to one or more attachment plug receptacles, and if the overcurrent protection of the BRANCH CIRCUIT to which the EQUIPMENT can be connected in accordance with the governing electrical code is unacceptable for the protection of the lampholder or receptacle circuits, each circuit shall have individual overcurrent protection at not more than 20 amperes provided as a part of the EQUIPMENT.

14.2 POWER SUPPLY - SECONDARY CIRCUITS

All external secondary-circuit interconnecting cables and all secondary-circuit wiring between UNITS shall be protected against burnout and damage to the insulation resulting from any overload or short-circuit condition that can occur during use of the equipment.

Exception: The overcurrent protection provided in the primary circuit of a transformer may be considered to be acceptable protection for the secondary circuit if it operates to protect the circuit under all overload conditions including short circuit.

Secondary circuits that are derived from power supplies or other sources that are either (1) inherently limited, or (2) include sensing devices whose operation achieves the same result (prevention of burnout and damage to insulation resulting from overload), or de-energizes the equipment are acceptable if the output wiring can carry the maximum current available from the power supply without discoloration or softening of insulation.

15 PRIMARY CIRCUIT CAPACITORS

Capacitors shall be approved by the appropriate agency.

16 FUSEHOLDERS

If fuses are used, a type readily replaceable in the country of use shall be selected.

a. A fuseholder shall be of the cartridge type and shall be suitable for the current and voltage of the circuit it protects.

   Panel mount fuseholders accessible from outside the product shall be of the type that do not allow live metal parts to be accessible during the operation of changing the fuse. Consideration must be given to the possibility of live contact through the fuse itself while it is being held and inserted into the fuseholder. Compliance is checked with the test finger in combination with the replacement fuse.

   Panel mount fuseholders must have the supply side of the circuit connected to the rearmost contact of the fuseholder to reduce risk of a hazard resulting if there is physical damage to the fuseholder.

   The wiring to the fuseholder must be clearly identified as to which wire connects to which fuseholder contact in the engineering drawings.

b. A cartridge fuseholder shall be constructed for use with a BRANCH-CIRCUIT fuse.

c. INDUSTRIAL CONTROL EQUIPMENT incorporating a fuseholder shall be so constructed that the fuses will be readily accessible when the switch contacts are open. The electrical arrangement of a single-throw switch shall be such that if it is connected as intended and the contacts are open, the fuse terminals will be dead.

d. The interrupting capacity shall be at least equal to the prospective short-circuit current at the place of installation.

   Exception: A lower interrupting capacity is permitted if another protective device (for example the general protection) having the necessary breaking capacity is installed on the supply side. In that case, the characteristics of the devices must be coordinated so that the energy let-through of the two devices in series does not exceed that which can be withstood without damage by the device on the load side and the conductors protected by these devices. The instantaneous, undelayed release of the device on the supply side shall be adjusted to a current value at least 20% below the current which can safely be interrupted by the device on the load side.

When a specific size fuse is required, the fuse MARKING shall be per DEC STD 178-3, heading 11, Labels for Specific Conditions.

17 INTERNAL WIRING

a. The wiring and connections between parts of the EQUIPMENT shall be protected from mechanical damage during installation and against accidental loosening.

b. All splices and connections shall be mechanically secure and shall provide electrical continuity. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection can result in a risk of fire, ELECTRIC SHOCK, or personal injury, or risk from electrical energy - high current levels.

c. Wires connected by soldering are not considered to be adequately secured, unless an additional fixing is provided near the terminal. This additional fixing, in the case of stranded conductors, shall clamp the INSULATION as well as the conductor.

d. The insulation on all internal wire of the EQUIPMENT shall be rated for the voltage and the temperature conditions of use. It shall also be considered with respect to other conditions of service to which it is likely to be subjected. Insulation shall be at least 1/32 inch (0.8 mm) thick if the internal wiring is subjected to movement, flexing, handling, or manipulation during mechanical maintenance.

e. A hole through which insulated wires pass in a sheet metal wall within the ENCLOSURE of the EQUIPMENT shall be provided with a smooth, well-rounded bushing or shall have smooth, well-rounded surfaces upon which the wires may bear to reduce the risk of abrasion of the insulation.

f. Wires shall be routed away from sharp edges, screw threads, burrs, fins, moving parts, drawers, hot surfaces, and the like, that can abrade the wire insulation.

g. Clamps and guides, either metallic or nonmetallic, used for routing stationary internal wiring shall be provided with smooth , well-rounded edges. The clamping action and bearing surface shall be such that abrasion or cold flow of the insulation cannot occur. Auxiliary nonconducting mechanical protection shall be provided under a metallic clamp that exerts pressure on a conductor having thermoplastic insulation less than 1/32 inch (0.8 mm) thick and having no overall braid.

h. Wiring that is subject to flexing during servicing such as that from a stationary part to a part mounted on a hinged door shall be provided with additional insulation at any point where it is flexed, unless the wiring is flexible cord.

   Exception: Additional insulation is not required if the test described in DEC STD 080-2, Wire Flexing Test, is completed without evidence of damage to the wiring.

i. Additional insulation, if used, shall be insulating sleeving, tubing, or a wrapping of not less than two layers of insulating tape. The insulation shall be made of materials rated for the temperature, voltage, and environment involved.

18 SPLICE INSULATION

A splice shall be provided with insulation thickness equivalent to that of the wires being spliced.

In determining if splice insulation consisting of coated-fabric, thermoplastic, or other types of tubing is acceptable, consideration is to be given to electrical and mechanical properties including dielectric voltage-withstand capability, heat resistance, and moisture resistance.

See subhead 1.17, Internal Wiring, item (i). Thermoplastic tape and heat-shrink tubing shall not be wrapped over a sharp edge or connection.

19 EXTERNAL INTERCONNECTIONS

19.1 OPEN EQUIPMENT

The means provided for the interconnection of OPEN EQUIPMENT, without covering panels, shall be evaluated on the basis of the interconnecting cable, cord, or harness being considered as internal wiring in accordance with the requirements of subhead 1.17, Internal Wiring.

19.2 ENCLOSED EQUIPMENT

The means provided for the interconnection of enclosed EQUIPMENT shall comply with the requirements of subhead 1.19.3, Interconnecting Cords and Cables, items (a) through (d) except that EQUIPMENT with provisions for interconnection by permanently installed field wiring shall comply with the requirements of subhead 1.22, Supply Connectors.

19.3 INTERCONNECTING CORDS AND CABLES

a. Cable assemblies and flexible cords provided for interconnection between sections of EQUIPMENT or between UNITS of a system shall be of a type that is acceptable for the service or use involved. Plugs, socket-outlets and couplers for industrial purposes, or used for domestic applications, shall not be used for CONTROL CIRCUITS. Cords and cables shall be properly clamped to the connector to avoid strain on the terminals.

b. Misalignment of male and female connectors, insertion of a multipin male connector in a female connector other than the one intended to receive it, and other manipulations of parts that are accessible to the OPERATOR shall not result in mechanical damage or a risk of fire, ELECTRIC SHOCK or injury to persons.

c. If either or each end of an external interconnecting cable terminates in a connector external to the ENCLOSURE on which there are one or more exposed contacts, risk of ELECTRIC SHOCK shall not exist between EARTH ground and any ground or any contact that is exposed on either the connector or its receptacle mounted on an ENCLOSURE surface while the connector is out of its receptacle.

d. Providing an interlock circuit in the cable to de-energize the exposed contacts whenever an end of the cable is disconnected is an acceptable method of complying with the requirement in item (c).

See *DEC STD 002-0 AC Power Wiring, Safety Grounding, Receptacle and Electrical Rating Information Requirements* for additional information.

20 TRANSFORMERS

A transformer employed in INDUSTRIAL CONTROL EQUIPMENT shall comply with the appropriate UL, CSA, and IEC transformer standards, unless the load is part of the EQUIPMENT, in which case the transformer shall comply with the temperature and dielectric voltage withstand tests in the test procedures.

Low voltage transformers intended for feeding functional extra-low voltage circuits shall not be of the autotransformer type.

Transformers shall be housed in one of the following ways:

a. Within their own ENCLOSURE,

b. Within the main ENCLOSURE of the EQUIPMENT, or

c. Within a combination of the methods described in items (a) and (b).

21 BLOWER MOTORS

Each blower shall be UL, CSA, or IEC approved for its application and be capable of delivering its maximum NORMAL LOAD without introducing risk of fire, ELECTRIC SHOCK, or injury to persons. The motor winding shall resist the absorption of moisture. Each blower motor shall incorporate one of the following forms of locked rotor protection:

a. Thermal protection.

b. Impedance protection.

c. Other protection that is shown by test to be equivalent to the protection specified in item (a).

22 SUPPLY CONNECTORS - WIRING TERMINALS AND LEADS

SUPPLY CONNECTIONS are considered to be those electrical connections that are made in the field when the EQUIPMENT is installed.

22.1 PERMANENTLY CONNECTED EQUIPMENT

a. INDUSTRIAL CONTROL EQUIPMENT intended for permanent connection to the branch-circuit (mains) shall have provision for connection to one of the applicable wiring systems in accordance with the governing electrical code.

   Exception: An ENCLOSURE need not have provision for the connection of a wiring system, such as a CONDUIT hub, a knockout or a fitting, if it is intended to be drilled or punched in the field to accommodate a wiring system and is provided with appropriate installation instructions.

b. The permanent connection shall be made by wiring terminals or leads for connection of conductors having an ampacity not less than the largest of the following ratings, unless the connection method of item (c) applies:

   1. The ampere rating of the EQUIPMENT.

   2. 125% of the full-load motor current or, in the case of power conversion equipment in which the input current is different from the full-load current, 125% of maximum rated input current.

   3. 125% of the ampere rating of the devices intended to be controlled for fixed electric space-heating equipment loads.

   4. For equipment controlling a direct-current motor intended to be operated from a rectified single-phase power supply:

      a. 190% of full load current if a half wave rectifier is used.

b. 150% of full load current if a full wave rectifier is used.

Exception: Item (4) does not apply if the product is marked in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions.

c. A pressure terminal connector, including one that is compression tool applied, for field connection to line or load need not be provided for EQUIPMENT with field wiring larger than No. 10 AWG (6.0 mm^2) if the construction complies with the following conditions:

1. COMPONENT terminal connectors are available from the EQUIPMENT manufacturer and one or more are specified for field installation on the EQUIPMENT.
2. A fastening device, such as a stud, nut, bolt, spring or flat washer, or the like, that is required for installation is (a) provided as a part of the COMPONENT terminal assembly, or (b) mounted on or separately packaged with the EQUIPMENT.
3. The installation of the terminal assembly does not involve the loosening or disassembly of a part other than a cover or other part giving access to the terminal location. The means for securing the terminal connectors shall be accessible for tightening before and after installation of the conductor.
4. If the pressure terminal connector provided in a COMPONENT terminal assembly requires the use of other than an ordinary TOOL for securing the conductor, instructions referencing use of the TOOL shall be included with the EQUIPMENT.
5. Installation of a pressure terminal connector in the intended manner shall result in a product that complies with the requirements in this standard.
6. The equipment is marked in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions.

d. It is assumed that INDUSTRIAL CONTROL EQUIPMENT having a current rating, or a horsepower rating with a full-load motor current will be connected with wire of a size determined in accordance with the governing electrical code. Unless marked for use only with wire rated 105 °C (221 °F), the size is to be based upon wire for a temperature 60 °C (140 °F) for EQUIPMENT rated 100 amperes or less.

e. If a wiring terminal will receive the next larger size conductor than that required in item (b) above, the terminal, shall comply with the secureness and pullout requirements with that size conductor, unless the EQUIPMENT is marked to restrict its use to only the smaller size conductor.

f. A lead that is intended to be installed in the field to a circuit conductor shall not be smaller than No. 18 AWG (0.82 mm^2) and the insulation, if of rubber or thermoplastic, shall not be less than 1/32 inch (0.8 mm) thick.

g. If binding head screws or machine screws are used as clamping means for field conductors, the size of the screw shall be not less than

1. No. 6 screws if for use with copper conductors No. 12 AWG or smaller;
2. No. 8 screws if for use with copper conductors larger than No. 12 AWG.

h. A terminal to which field wiring is to be connected shall be a pressure wire connector.

Exception: A terminal to which No. 10 AWG (6.0 mm^2) or smaller wiring connections are to be made may consist of a clamp or binding screw with a terminal plate having upturned lugs or the equivalent to hold the wire in position.

i. A field-wiring pressure wire connector provided with or specified for use with INDUSTRIAL CONTROL EQUIPMENT shall comply with one or more of the following, as applicable:

   1. The performance requirements in the Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   2. A nominal 0.110-, 0.125-, 0.187-, or 0.250-inch wide quick-connect terminal shall comply with the requirements for quick-connect terminals, UL 310. Other sizes of quick-connect terminals shall be investigated with respect to such areas as crimp pullout, engagement-disengagement forces of the connector and tab, and temperature rises in accordance with UL 310. See DEC STD 002-0.
   3. A wire-binding screw to which field-wiring connections are made shall be No. 8 or larger.

      Exception: A No. 6 screw may be used at a terminal intended only for connection of a No. 14 AWG conductor.
   4. A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick for a No. 14 AWG (1.5 mm^2) or smaller wire, and not less than 0.050 inch (1.27 mm) thick for a wire larger than No. 14 AWG (2.5 mm^2). There shall be at least two full threads in the plate.
   5. A terminal plate formed from stock having the required thickness specified in item 4 above may have the metal extruded at the tapped hole for the binding screw to provide two full threads.
   6. A wire-binding screw shall thread into metal.

22.2 CORD-CONNECTED EQUIPMENT

INDUSTRIAL CONTROL EQUIPMENT intended to be cord connected to the BRANCH-CIRCUIT (mains) shall be provided with an acceptable length, size, and type of hard-service or junior hard-service flexible cord, such as Type S, SJ, or the equivalent accepted in the country of usage, that is terminated in an attachment plug and rated for the temperature and voltage involved.

Strain relief shall be provided so that a mechanical stress on the cord will not be transmitted to terminals, splices, or internal wiring.

At the point at which the cord passes through the ENCLOSURE wall, protection shall be provided to prevent cord abrasion.

Means shall be provided to prevent the flexible cord from being pushed into the ENCLOSURE of the EQUIPMENT through the cord entry hole if such displacement is likely to subject the cord to mechanical damage or to expose the cord to a temperature higher than that for which it is rated or if it is likely to reduce spacings such as to a metal strain-relief clamp below the minimum acceptable values.

22.3 CORD-CONNECTED PROGRAMMING AND DIAGNOSTIC UNITS

Auxiliary UNITS such as portable programmers intended to be used only on a temporary basis to diagnose or program industrial controls shall, comply with the requirements of *DEC STD 119 Digital Product Safety Design Handbook*. These UNITS may be considered as a subsystem of the industrial electronic control equipment.

23 SWITCHES AND CONTROLS

Switches and controls shall comply with the requirements of CSA Standards C22.2 No. 14, C22.2 No. 24, C22.2 No. 55, and C22.2 No. 111, and IEC 2041.1, clause 5.6.2, in so far as they apply.

A switch or other CONTROL DEVICE shall have a current and voltage rating not less than that of the circuit which it controls when the equipment is operated under any condition of normal service.

The position of a manual switching means such as the position of the handle of a manual motor controller, drum controller, or the like, other than a push-button station, a selector switch, or both, shall be marked as a guide to proper operation. Such MARKING shall not be able to be rubbed off, washed off, or otherwise rendered unreadable during normal use.

24 ELECTRIC LIGHTING EQUIPMENT

Lampholders for incandescent lamps of the screw-shell type shall comply with the requirements of CSA Standard C22.2 No. 43. Other types of lampholders shall be the subject of investigation.

25 SECONDARY CIRCUITS

All secondary circuits such as an overload relay circuit shall be judged under the requirements for PRIMARY CIRCUITS.

A circuit supplied from a Class 2 transformer rated at 30 volts RMS sinusoidal or less need not be tested and qualified under this standard. Circuit switch interconnect equipment shall comply with subhead 1.28, Derived Low Voltage.

26 LIMITED ENERGY

a. Circuits supplied by a safety isolating transformer (IEC 950 requirements) secondary winding having a maximum available capacity of 200 volt-amperes or less at a maximum potential of 100 volts need not be the subject of further investigation. For a multiple winding transformer, a secondary winding used for limited energy circuits need not be the subject of further investigation if the connected circuit complies with the separation of circuits requirements under subhead 1.29, Separation of Circuits.

b. Maximum available capacity is the maximum product of simultaneously measured values of secondary voltage and secondary current. The values are to be determined by placing a resistive load on the secondary winding and measuring available current and voltage while varying the resistive load from open circuit to short circuit in 1.5 to 2.5 minutes.

27 BATTERY POWER

a. A circuit involving a potential of not more than 42.4 volts peak supplied by a primary (nonrechargeable) battery other than a lithium battery, that complies with all the performance requirements for a Class 2 transformer and complies with the separation of circuits requirements under subhead 1.29, Separation of Circuits, does not require further qualification and testing.

b. A circuit involving a potential of not more than 42.4 volts peak supplied by a secondary (rechargeable) battery other than a lithium battery, that complies with all the performance requirements for a Class 2 transformer does not require further qualification and testing if the battery is charged by the secondary circuit of an isolation transformer complying with Class 2, isolated power, limited energy, and the circuit complies with the separation requirements under subhead 1.29, Separation of Circuits.

28 DERIVED LOW VOLTAGE

Spacings within a circuit derived from a limiting impedance in a primary circuit need not be further investigated provided that the impedance limits the product of the current through and the voltage across this impedance to a value not exceeding the wattage rating of the impedance and to a level not exceeding 15 watts when a direct short is applied across the remainder of the circuit.

For purposes of applying this requirement, a secondary circuit requiring further evaluation shall be considered as equivalent to a primary circuit.

28.1 MACHINE EXTRA-LOW VOLTAGE (MELV)

28.1.1 Requirements

MELV circuits, whose uninsulated parts may be accessible to touch by OPERATORS, are required to exhibit safe touch voltages both under normal operating conditions and after a single fault, such as a breakdown of a layer of BASIC INSULATION or failure of a single COMPONENT.

Under normal conditions, in a single MELV circuit or in interconnected MELV circuits the voltage between any circuit parts or between any circuit part and SAFETY EARTH GROUND or BODY shall not exceed 42.4 V peak or dc. In the event of a single failure of BASIC INSULATION or a COMPONENT, the voltages in a MELV circuit shall not exceed 42.4 V peak or dc for more than 0.2 s with a limit of 65 V peak or dc.

For fault conditions the requirements of the above sentence shall be assured for each part of the MELV circuit by one of the following methods:

PREFERRED

a. Separation of the MELV circuit, by means detailed under subhead 1.28.1.2, Insulation, as below:
   1. From PRIMARY CIRCUITS by DOUBLE or REINFORCED INSULATION.
   2. From SECONDARY CIRCUITS operating at hazardous voltages by SUPPLEMENTARY INSULATION.
   3. From SECONDARY CIRCUITS operating at FELV by BASIC INSULATION.

b. Separation of the MELV circuit from other circuits by a conductive screen or other conductive parts connected to SAFETY EARTH GROUND, as detailed under subhead 1.28.1.3, Shields Connected to Safety Earth Ground.

ACCEPTABLE BUT NOT RECOMMENDED

c. Adequate SAFETY EARTH GROUNDING of the MELV circuit as detailed under subhead 1.28.1.3, Shields Connected to Safety Earth Ground (Class I Equipment only).

d. Provision of a means of protection which prevents the voltage limits from being exceeded, as detailed under subhead 1.28.1.3, Shields Connected to Safety Earth Ground.

A SAFETY ISOLATING TRANSFORMER provides separation by method (a) or (b).

In a single circuit, (for example, transformer-rectifier circuit) it is possible for some parts to be MELV and OPERATOR accessible, while others are not.

Different parts of the same MELV circuit may be protected by different methods, for example:

1. Method b within a power transformer feeding a bridge rectifier.
2. Method a for the ac SECONDARY CIRCUIT.
3. Method c at the output of the bridge rectifier.
4. Method d at a remote part of the MELV circuit.

For normal conditions the MELV voltage limit is the same for FELV; a MELV circuit may be regarded as a FELV circuit with an additional degree of safety under fault conditions.

EQUIPMENT shall be constructed as follows:

a. Means shall be provided, other than terminal pressure, to prevent ring-tongued and similar terminations pivoting so as to reduce CREEPAGE DISTANCES and CLEARANCES between MELV circuits and parts at FELV or hazardous voltage below the specified minimum values.

b. In multiway plugs and sockets and elsewhere where shorting could otherwise occur, means shall be provided to prevent contact between parts at FELV or hazardous voltage and MELV circuits due to loosening of a terminal or breaking of a wire at a termination.

c. Uninsulated parts at FELV or hazardous voltage shall be covered or shielded or so located as to avoid accidental shorting to MELV circuits, for example, by TOOLS or test probes.

d. It shall not be possible to mate plugs and sockets in such a way that a MELV circuit is connected to parts at hazardous voltage. This may be achieved by the design or the location of the connector. The requirements of this sub-clause do not apply where the possibility of contact between MELV and FELV circuits is being considered and the MELV circuit is protected as described under subhead 1.28.1.3, Shields Connected to Safety Earth Ground.

28.1.2 Insulation

Where part of a MELV circuit is separated from parts of other circuits by INSULATION only, this may be achieved by one of the following means (other means are not precluded):

a. Permanent separation by barriers, routing or fixing.

b. INSULATION of all internal wiring rated for the highest WORKING VOLTAGE present.

c. INSULATION on either the wiring of the MELV circuit or that of the other circuits meeting the SUPPLEMENTARY INSULATION or REINFORCED INSULATION requirements for the highest WORKING VOLTAGE present.

d. An additional layer of INSULATION, where required, over either the wiring of the MELV circuit or that of the other circuits.

This is not to imply this INSULATION is needed from SAFETY EARTH GROUND or wires connected to SAFETY EARTH GROUND.

28.1.3 Shields Connected to Safety Earth Ground and Other Protection Means

Where parts of MELV circuits are separated from parts at hazardous voltage by a screen or other conductive parts connected to SAFETY EARTH GROUND, the parts at hazardous voltage shall be separated from the parts connected to SAFETY EARTH GROUND by BASIC INSULATION.

Parts of MELV circuits protected by grounding shall be connected to the SAFETY EARTH GROUND terminal in such a way that the requirements under subhead 1.28.1, Machine Extra-Low Voltage, are met by relative circuit impedances and/or by the operation of a protective device and shall be separated from parts of other circuits by BASIC INSULATION.

Parts of MELV circuits may be protected by a reliable means of protection such that the requirements under subhead 1.28.1, Machine Extra-Low Voltage, are met. Such parts shall be separated from parts of other circuits by BASIC INSULATION.

Reliable protective means may be COMPONENTS or circuits such as FUSES, CIRCUIT BREAKERS, electronic over-voltage protection, electronic over-current protection.

28.2 FUNCTIONAL EXTRA-LOW VOLTAGE (FELV) Circuit

Under normal conditions, in a single FELV circuit or in interconnected FELV circuits the voltage between any circuit parts or between any circuit part and SAFETY EARTH GROUND or BODY shall not exceed 42.4 V peak or dc.

Under single fault conditions, a FELV circuit might assume a hazardous voltage.

28.3 INTERCONNECTION WITH NON-MELV CIRCUITS

MELV circuits may be connected to other circuits provided that the requirements under subhead 1.28.1, Machine Extra-Low Voltage, are met, except that MELV circuits shall not be conductively connected to the primary power supply circuit (including the NEUTRAL) within the EQUIPMENT.

28.4 TELECOMMUNICATION CIRCUIT INTERCONNECTION

The interface between the internal MELV (logic) circuits and telephone administration circuits shall maintain the required MELV isolation.

For CREEPAGE, CLEARANCE, and interface COMPONENT requirements for telecommunication applications refer to the following standards:

DEC STD 053-0 Requirements for Interface Between Data Circuit-Terminating Equipment (DCE) and the Public Switched Telephone Network (PSTN) in the USA and Canada

DEC STD 053-1 Requirements for Interface Between Data Circuit-Terminating Equipment (DCE) and the Public Switched Telephone Network (PSTN) Worldwide Except the USA and Canada (Draft)

NOTE

Creepage distance and isolation requirements for North America are basically different from those for other international areas.

For indirect connection, where the modem or other interface device is an approved standalone type, the data interface (EIA RS 232 for example) circuit provided for connection to the modem shall meet MELV requirements. Isolation between that MELV circuit and the telephone line is taken to reside in the modem.

29 SEPARATION OF CIRCUITS

Secondary circuits that have not been found to comply with the requirements under subhead 1.25, Secondary Circuits, shall be separated from other circuits in accordance with items (a) through (e) below. Insulated conductors shall be separated by barriers or segregated from:

a. Each other if used in different internal wiring circuits, and

b. Uninsulated LIVE PARTS connected to different circuits.

Exception: Conductors need not comply if they are provided with insulation rated for the highest voltage involved.

a. Segregation of insulated conductors shall be accomplished by clamping, routing, or equivalent means that provides permanent separation from insulated or uninsulated LIVE PARTS of a different circuit.

b. Means shall be provided for separation of field-installed conductors of the secondary circuit from:

   1. Field- and factory-installed conductors connected to any other circuit.

   2. Uninsulated LIVE PARTS of any other circuit of the device.

c. Field-installed conductors may be segregated from each other and from uninsulated LIVE PARTS of the INDUSTRIAL CONTROL EQUIPMENT connected to different circuits by arranging the location of openings in an ENCLOSURE for the various conductors with respect to the terminals or other uninsulated LIVE PARTS so that there is little likelihood of intermingling of the conductors or parts of different circuits.

d. With reference to item (c), if the number of openings in the ENCLOSURE does not exceed the minimum required for the intended wiring of the INDUSTRIAL CONTROL EQUIPMENT, and if each opening is located opposite a set of terminals, it is to be assumed that a conductor entering an opening will be connected to the terminal opposite that opening. If more than the minimum number of openings are provided, the possibility of a conductor entering an opening other than the one opposite the terminal to which it is intended to be connected and the likelihood of it contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit is to be investigated.

e. To determine if INDUSTRIAL CONTROL EQUIPMENT complies with the requirement of item (b), it is to be wired as intended for service with a reasonable amount of slack left in each conductor within the ENCLOSURE and average care is to be exercised in stowing the slack into the wiring compartment.

f. The conductor insulation of either system has, or shall have in the case of field installed wiring, a voltage rating at least twice the highest voltage involved.

g. Barriers shall be of adequate mechanical strength and reliably held in place and constructed as follows:

   1. Metal barriers shall have a thickness at least as great as that required by Table 1.
   2. Insulating barriers shall be not less than 0.71 mm (0.028 inch) thick and, when located between conductors and bare LIVE PARTS of different circuits, shall also comply with subhead 1.31, Spacings (Creepage and Clearance Distances) item (g).
   3. Unclosed openings in barriers for the passage of conductors shall be not larger than 6.4 mm (0.25 inch) in diameter and the number of unclosed openings shall not exceed one per required conductor.
   4. All openings for wires and closures for other openings, shall present a smooth surface wherever an insulated wire may be in contact with it.

h. When grounded shielding is used, it will be subject to investigation to determine compliance.

30 ISOLATION DEVICES

Relays, transformers, and the like, complying with the requirements in this standard are considered as providing the required isolation.

a. If an impedance is provided to obtain the required isolation then:

   1. Each line voltage circuit shall be provided with impedance such that V/Z is not more than 5 milliamperes, where V equals the open circuit voltage of the line circuit and Z is the minimum impedance including tolerances; and
   2. Resistors or capacitors forming the impedance shall operate at not more than 50% of their nominal wattage or voltage rating respectively and shall not operate at more than 100% of these ratings when shorted across the maximum voltage obtained if a malfunction occurs in the secondary circuit.

   With regard to the requirements in item (1) a tachometer, a transducer, or a similar feedback device that is isolated from line voltage circuits is not considered to be a power-supplying source.

b. A pulse transformer provided with isolation shall be acceptable for the application provided it has a dielectric voltage-withstand capability of not less than 3750 volts ac rms or 5303 volts dc for 1 minute if it is relied upon to provide the isolation between primary and secondary circuits.

c. An optic isolator shall have an isolation voltage of at least 3750 volts ac rms.

31 SPACINGS (CREEPAGE AND CLEARANCE DISTANCES)

Other than as noted in items (a) and (s), the electrical spacings in INDUSTRIAL CONTROL EQUIPMENT shall be at least those specified in Table 8 and Table 10 for UL and IEC. Table 9 and Table 11 shall be used for CSA.

a. The spacings in INDUSTRIAL CONTROL EQUIPMENT in which transient voltages are known and controlled by a transient suppressive device shall not be less than those specified in Table 10, except that spacings at a FIELD-WIRING TERMINAL shall be in accordance with Table 8 and item (q).

b. The transient suppressive device specified in item (a) shall prevent peak transient voltages from exceeding 300% of the instantaneous peak working voltage or 300 volts, whichever is greater. See subhead 2.4, Transient Voltage-Surge Suppression.

c. With reference to the requirements in item (a), INDUSTRIAL CONTROL EQUIPMENT shall have provision for the maintenance of clean, dry electrical surfaces, such as conformal coating on a printed wiring board, or other means of protecting EQUIPMENT from atmospheres containing dust.

d. The primary circuit spacings in industrial control power supplies intended for use in a UL Type 12 enclosure or equivalent, shall be at least those specified in Tables 12 and 13.

e. Except as stated in items (f) and (h), spacings shall not be less than those specified in Table 9 or 11. Greater spacings may be required if the ENCLOSURE, because of it's size, shape, or the material used, is not considered to be sufficiently rigid to warrant the minimum spacings. Spacing requirements are not applied to the internal spacings of solid-state electronic COMPONENTS such as triacs, diodes, and SCRs.

f. The spacings within a snap switch, lampholder, or other COMPONENT supplied as part of process control equipment shall comply with the requirements of the standard covering the COMPONENT or shall be not less than those specified in item (e), whichever are smaller.

g. If barriers are used to obtain the required spacings they shall meet the following requirements:

   1. Bare LIVE PARTS shall be supported on heat resistant, absorption resistant insulating material such as phenolic composition, porcelain, cold molded composition, or some suitable equivalent, that will withstand the most severe conditions likely to be met in service.

   2. Insulating material that may be subjected to the influence of the arc formed by the opening of a set of contacts shall be suitable for the particular application.

   3. Be not less than 0.7 mm (0.028 inches) thick if spacings are less than half those specified;

   4. Be not less than 0.3 mm (0.012 inches) thick if spacings are not less than half those specified; and

   5. Be reliably held in place.

   Adhesives used to hold barriers in place may be subject to investigation to ensure adequate life under conditions of normal use.

Insulating materials having a thickness less than that specified in items (g) (3) and (g) (4) may be used if, upon investigation, they are found to have mechanical and electrical properties adequate for all conditions of service.

h. The electrical spacings of EQUIPMENT that is intended to be used in a CONTROLLED ENVIRONMENT and is marked in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions shall be not less than specified in items (1) and (2) below:

   1. The electrical spacings for PRIMARY CIRCUITS may be 85% of the value specified in Table 9.
   2. No electrical spacings are specified for secondary circuits if they comply with the following:
      a. The circuits are not SAFETY CIRCUITS;
      b. The circuits are supplied by a transformer winding for which the output voltage does not exceed 100 V or the maximum available output at a voltage over 100 V does not exceed 200 VA; and
      c. The spacings are sufficient to withstand without breakdown the applicable dielectric strength test specified in subhead 2.3.2, CSA Requirements.

i. The spacing at wiring terminals shall be measured with appropriate wires in place and connected to the terminals as in actual service.

j. All bare current-carrying parts connected to different circuits shall be spaced from each other as though they were parts of opposite polarity, in accordance with the requirements of item (e) above, and shall be judged on the basis of the highest voltage involved.

k. The spacing at a FIELD-WIRING TERMINAL is to be measured with the wire connected to the terminal as if in service. The connected wire is to be the next larger size than would normally be required for the EQUIPMENT rating if the terminal will accommodate it or if the EQUIPMENT is not marked to restrict its use.

l. The spacings specified in column B of Table 8 are applicable to EQUIPMENT:

   1. Rated 1-horsepower (746 W output) or less, 720 volt amperes break pilot duty or less; or not more than 15 amperes at 51 - 150 volts, 10 amperes at 151 - 300 volts, or 5 amperes at 301 - 600 volts.
   2. Of the type described in item (1) above which controls more than one load provided the total load connected to the line at one time does not exceed 2 horsepower (1492 W output), 1440 volt-amperes, or have a current rating greater than 30 amperes at 51 - 150 volts, 20 amperes at 151 - 300 volts, or 10 amperes at 301 - 600 volts.

m. The spacings specified in column C of Table 8 apply only to EQUIPMENT rated at 300 volts or less, and 1 horsepower (746 W output) or less or 2000 volt-amperes or less per pole and to a device that has a current rating per pole of 15 amperes or less at 51 - 150 volts, 10 amperes at 151 - 300 volts, or both.

n. A motor controller rated more than 1 horsepower (746 W output) at 151 - 300 volts that complies with the spacings specified in column A of Table 8 for such rating may have an additional rating of 1 horsepower or less at 301 - 600 volts. See also item (m) for multipole products.

o. A motor controller rated more than 1 horsepower (746 W output) at 51 - 150 volts that complies with the spacings specified in column A of Table 8 for such rating may have an additional rating of 1 horsepower or less at 51 - 300 volts. See also item (n) for multipole products.

p. In an open-type controller, the spacings between LIVE PARTS and metal parts that may be grounded, such as the heads of mounting screws that pass through an insulated panel, shall be judged as if they were grounded parts within an ENCLOSURE. The spacing between uninsulated LIVE PARTS and the surface on which the device may be mounted is to be judged as if the mounting surface were part of an ENCLOSURE.

q. In a circuit involving no potential of more than 50 volts, other than as noted in item (d), spacings at FIELD-WIRING TERMINALS may be 1/8 inch (3.2 mm) through air and 1/4 inch (6.4 mm) over surface, and spacings elsewhere may be 1/16 inch (1.6 mm) through air or over surface if the insulation and clearances between the low-potential circuit are in accordance with the requirements that are applicable to the high-potential circuit.

r. For a pilot light consisting of a lampholder in series with a dropping resistor or connected to an autotransformer, the spacings shall be:

   1. At least 3/64 inch (1.2 mm) between uninsulated LIVE PARTS of opposite polarity at or within a lampholder - an inherent lampholder spacing - rated 250 volts or less and at least 1/8 inch (3.2 mm) for a lampholder rated more than 250 volts;

   2. At least those specified in Table 8 or in item (q) between uninsulated LIVE PARTS of opposite polarity - other than at or within the lampholder - based on the normal operating voltage existing between such parts; and

   3. At least those specified in Table 8 between uninsulated LIVE PARTS and grounded parts, exposed dead metal parts, or the ENCLOSURE based on the line voltage of the pilot-light circuit.

s. In a series circuit, the spacings between resistor terminals, transformer taps, and the like are to be based on the normal operating voltage existing between such parts.

t. In a pushbutton, selector switch, limit switch, or the like, opposite polarity is not considered to exist on any one pole, including double-throw arrangements; but opposite polarity is considered to exist between poles and between LIVE PARTS on adjacent units unless the parts in question are connected to the same line terminal or conductor.

u. The spacings at fuses and fuseholders are to be measured with the fuses having maximum standard dimensions in place, and shall be at least the spacings specified in column A of Table 8.

v. Where insulation is provided in lieu of spacings between a magnetic coil winding and other uninsulated LIVE PARTS or grounded dead metal parts, insulation may differ from that required by subhead 1.32, Insulation Barriers. Crossover-lead insulation and insulation under coil terminals secured to the coil winding need not comply with the requirements in items (a) and (b) if for thicknesses less than 0.013 inch, (0.33 mm) or where only through air space is provided, there is no indication of breakdown in the system as a result of the tests described in the Dielectric Test.

w. A ceramic, vitreous-enamel, or similar coating is not acceptable as insulation in place of spacings unless, upon investigation, the coating is found to be acceptable for the purpose.

x. If contact arms, blades, or the like, in a motor controller remain connected to the motor load terminals when in the off position, the spacing from such parts to the ENCLOSURE or to exposed dead metal parts that are isolated (insulated) shall be at least 1/8 inch (3.2 mm) more than the spacings required for stationary uninsulated LIVE PARTS.

y. Film-coated wire is considered to be an uninsulated LIVE PART in determining compliance with the spacing requirements in this standard.

z. For an ENCLOSURE without CONDUIT openings or knockouts, spacings not less than the minimum specified in this section shall be provided between uninsulated LIVE PARTS and a CONDUIT bushing installed at any location likely to be used during installation. A permanent MARKING on the ENCLOSURE, a template, or a full-scale drawing furnished with the EQUIPMENT may be used to identify such locations.

aa. For the spacing between an uninsulated LIVE PART and a bushing installed in a knockout, it is to be assumed that a bushing having the dimensions specified in Table 14 is in place, in conjunction with a single locknut installed on the outside of the ENCLOSURE.

NOTE

The following tables define minimum spacing requirements for UL/IEC and CSA. In some instances values differ significantly between UL/IEC and CSA requirements. These differences must be given careful consideration when designing products.

Table 8: Minimum Acceptable Spacings - UL/IEC

(A) General Industrial Control Equipment

Minimum Spacing, Inch (mm)

Potential Between Parts Involved in Volts		31 - 150	151 - 300	301 - 750
Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded part other than the enclosure, or exposed metal part	Though air or oil	1	1/4 (6.4)	3/8 (9.5)
	Over surface	/8(c) (3.2) 1/4 (6.4)	3/8 (9.5)	1/2 (12.7)
Between any uninsulated live part and the walls of a metal enclosure including fittings for conduit or armored cable (d)	Shortest distance	1/2 (12.7)	1/2 (12.7)	1/2 (12.7)

(B) Device having Limited Ratings (a)

Minimum Spacing, Inch (mm)

Potential Between Parts Involved in Volts		31 - 300	301 - 750
Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded part other than the enclosure, or exposed metal part	Though air or oil	1	3
	Over surface	/16(c) (1.6) 1 /8(c) (3.2)	/16(c) (2.2) 3/8 (9.5)
Between any uninsulated live part and the walls of a metal enclosure including fittings for conduit or armored cable (d)	Shortest distance	1/4 (6.4)	1/2 (12.7)

(C) Other Devices (b)

Minimum Spacing, Inch (mm)

Potential Between Parts Involved in Volts		31 - 150	151 - 300
Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded part other than the enclosure, or exposed metal part	Though air or oil	1	1/4 (6.4)
	Over surface	/8(c) (3.2) 1/4 (6.4)	1/4 (6.4)
Between any uninsulated live part and the walls of a metal enclosure including fittings for conduit or armored cable (d)	Shortest distance	1/4 (6.4)	1/4 (6.4)

a. See item (l)
b. See item (m)
c. The spacing between field wiring terminals of opposite polarity and the spacing between a field wiring terminal and a grounded dead metal part shall be at least 1/4 inch if short-circuiting or grounding of such terminals may result from projecting strands of wire.
d. For the purpose of this requirement, a metal piece attached to the enclosure is considered to be a part of the enclosure if deformation of the enclosure is likely to reduce the spacings between the metal piece and uninsulated live parts.

Table 9: Minimum Acceptable Spacings - CSA

Minimum Spacing, mm

Item	Parts Involved	At other than field wiring terminals: Voltage Range	Through Air	Over Surface	At field wiring terminals: Through Air	Over Surface
1	Low voltage primary and secondary circuits other than items 2, 3, and 4					
	(a) Spacing A (1)	31 to 150	3.2	6.4	6.3 (4)	6.3
		152 to 300	6.4	9.5	6.3	9.5
		301 to 750	9.5	12.7	9.5	12.5
	(b) Spacing B (2)	31 to 750	12.7	12.7	12.5	12.5
2	Low Voltage primary and secondary circuits in equipment rated at 2000 V-A and less					
	(a) Spacing A (1)	31 to 150	1.6 (5)	1.2 (5)	6.3 (5)	6.3 (5)
		151 to 300	1.6 (5)	1.6 (5)	6.3 (5)	9.5 (5)
		301 to 750	3.2 (5)	3.2 (5)	6.3 (5)	6.3 (5)
	(b) Spacing B (2)	31 to 150	3.2 (5)	6.3	6.3	
		151 to 300	4.7	4.7	6.3	6.3
		301 to 750	6.3	6.3	6.3	6.3
3	Low voltage secondary circuits in which the short-circuit power between conductors is limited by an isolating transformer to 1500 V-A (7) and no fire hazard will result from short-circuit					
	(a) Spacing A (1)	31 to 150	0.8 (5)	0.8 (5)	6.3 (4)	6.3 (4)
	151 to 300	1.2 (5)	1.2	1.2 (5)	6.3 (4)	6.3 (4)
	301 to 750	1.6 (5)	1.6 (5)	6.3 (4)	6.3 (4)	
	(b) Spacing B (2)	31 to 150	1.2 (5)	1.2 (5)	6.3	6.3
	151 to 300	1.2 (5)	1.2 (5)	6.3	6.3	

1. Spacing A applies between bare live parts of opposite polarity and between bare live parts and non-current-carrying metal parts other than the enclosure.
2. Spacing B applies between bare live parts and the walls of a metal enclosure including fittings for conduit or armored cable.
3. May be 3.2 mm if spacing is rigidly maintained and cannot be reduced during assembly of the component into the device.
4. May be 3.2 mm if short-circuiting or grounding of the terminals will not result from projecting strands of wire.
5. This spacing is acceptable only if it is rigidly maintained. The acceptability of such a spacing at solder terminals will be the subject of investigation.
6. For purposes of this requirement, the short-circuit volt ampere limit is defined as the product of the open-circuit volts and the short-circuit amperes of the transformer and these are RMS values in an ac circuit. Suitable resistance or inductance externally connected in series with the secondary winding of the transformer may be used to limit the short-circuit current to comply with these power limitations.
7. The spacings specified for functional extra-low voltage circuits do not apply to Class 2 circuits or self-generating millivolt circuits. No spacings are specified for such circuits.

Table 9 (Cont.): Minimum Acceptable Spacings - CSA

Minimum Spacing, mm

Item	Parts Involved	Voltage Range	At other than field wiring terminals: Through Air	At other than field wiring terminals: Over Surface	At field wiring terminals: Through Air	At field wiring terminals: Over Surface
	301 to 750	1.6 (5)	1.6 (5)	6.3	6.3	
4	Functional extra-low voltage and low voltage secondary circuits in which the short-circuit power between conductors is limited by an isolating transformer to 150 V-A (3) and no fire hazard will result from short-circuit (3)					
	(a) Spacing A (1)	0 to 150			No spacings are specified	
	(b) Spacing B (2)	0 to 150			No spacings are specified	
5	Functional extra-low voltage secondary circuits (7)					
	(a) Spacing A (1)	0 to 30	0.8	0.8	6.3 (4)	6.3 (4)
	(b) Spacing B (2)	0 to 30	1.2	1.2	6.3 (4)	6.3 (4)
6	Functional extra-low voltage secondary circuits (Class 2)					
	(a) Spacing A (1)	0 to 30			No spacings are specified	
	(b) Spacing B (2)	0 to 30			No spacings are specified	

NOTES

- **No spacings are specified between bare live parts of opposite polarity or between bare live parts and non-current-carrying metal parts including the enclosure, provided that the leakage current between such parts, when connected through a 1500 ohm resistor, is reliably limited to not more than 5 mA by means of a fixed resistance or impedance that is an integral part of the equipment. A capacitor is not acceptable for this purpose.**
- **Signal input circuits intended for direct connection to circuits exceeding 30 V or exceeding 30 V to ground require item 2 spacings in Table 9 (CSA).**
- **The isolating transformer specified in Items 3 and 4 need not be an integral part of the equipment, provided that it is supplied by the manufacturer of the equipment and the equipment is marked in accordance with DEC STD 178-3, heading 11, Labels for Specific Conditions, to ensure that the proper transformer is used.**
- **All voltages specified are root-mean-square values.**
- **On printed circuit boards, the spacings in item 2 of Table 8 may be reduced by 0.4 mm, provided that the voltage involved is less than 300 V and the parts are coated with a suitable coating that passes the Impact Test.**

Table 10: Minimum Acceptable Spacings for Products with Known and Controlled Transient Voltages (UL/IEC)

Minimum Spacing, mm, Between Any Uninsulated Live Part and an Uninsulated Live Part of Opposite Polarity, Uninsulated Grounded Part Other Than the Enclosure, or Exposed Metal Part

Short-Circuit Power (a)	Peak Working Voltage	Through Air or Oil		Over Surface	
More than 10 kVA, for use where transient voltages are known and controlled	0 - 50	0.030	(0.76)	0.030	(0.76)
		0.075	(1.91)	0.100	(2.54)
	51 - 225	0.150	(3.81)	0.200	(5.08)
		0.300	(7.62)	0.400	(10.16)
	226 - 450				
	451 - 900				
More than 500 VA but not more than 10 kVA	0 - 50	0.030	(0.76)	0.030	(0.76)
		0.060	(1.52)	0.060	(1.52)
	51 - 225	0.100	(2.54)	0.100	(2.54)
		0.200	(5.08)	0.200	(5.08)
	226 - 450				
	451 - 900				
500 VA or less	0 - 36	0.012	(0.30)	0.012	(0.30)
		0.016	(0.40)	0.016	(0.40)
	37 - 72	0.030	(0.76)	0.030	(0.76)
		0.045	(1.14)	0.045	(1.14)
	73 - 100	0.060	(1.52)	0.060	(1.52)
		0.100	(2.54)	0.100	(2.54)
	101 - 225				
	226 - 450				
	451 - 900				

Between Any Uninsulated Live Part and the Walls of a Metal Enclosure Including Fittings for Conduit or Armored Cable (b)

Short-Circuit Power (a)	Peak Working Voltage	Through Air or Oil	Over Surface

a. Maximum short-circuit power is the product of the open-circuit voltage and the short-circuit current available at the supply terminals when protective devices are by-passes.
b. A metal piece attached to the enclosure is considered to be part of the enclosure if deformation of the enclosure is likely to reduce spacings between the metal piece and uninsulated live parts. Spacings specified for parts other than enclosure walls are acceptable to metal walls of a subassembly mounted inside another enclosure if spacings in the subassembly are rigidly maintained.
c. Where deflection of an enclosure wall cannot reduce the through-air spacing to the enclosure wall, the spacing through air may be 0.250 inch.

Table 10 (Cont.): Minimum Acceptable Spacings for Products with Known and Controlled Transient Voltages (UL/IEC)

		Between Any Uninsulated Live Part and the Walls of a Metal Enclosure Including Fittings for Conduit or Armored Cable (b)			
Short-Circuit Power (a)	Peak Working Voltage	Through Air or Oil		Over Surface	
More than 10 kVA, for use where transient voltages are known and controlled	0 - 50	0.500 (c)	(12.7)	0.250	(6.35)
		0.500 (c)	(12.7)	0.500 (c)	(12.7)
	51 - 225	0.500 (c)	(12.7)	0.500 (c)	(12.7)
		0.500 (c)	(12.7)	0.500 (c)	(12.7)
More than 500 VA but not more than 10 kVA	0 - 50	0.500 (c)	(12.7)	0.500 (c)	(12.7)
		0.500 (c)	(12.7)	0.500 (c)	(12.7)
	51 - 225	0.500 (c)	(12.7)	0.500 (c)	(12.7)
	226 - 450				
	451 - 900				
500 VA or less	0 - 36	0.500 (c)	(12.7)	0.250	(6.35)
	37 - 72	0.500 (c)	(12.7)	0.250	(6.35)
		0.500	(12.7)	0.500	(12.7)
		73 - 100	(12.7)	0.500	(12.7)
	101 - 225				
	226 - 450				
	451 - 900				

Table 11: Conductor Spacings for Printed Circuit Boards (CSA)

		Transients Limited	
Volts ac rms or dc	Transients Not Limited mm	Coated* mm	Uncoated mm
50	0.85	0.1	0.2
100	1.0	0.1	0.2
150	1.1	0.25	0.5
300	2.2	0.75	1.6
600	4.5	1.8	3.2
1000	7.1	3.2	5.5

* The coating will have passed the Printed-Circuit Board Coating Test.

NOTE

Where a spacing in Table 9 is less than the one in Table 11, the former may be used.

Table 12: Power Supply Primary-Circuit Spacings Other Than At Field-Wiring Terminals

Potential Involved in Volts		Minimum Spacings (a), Inch (mm)			
rms	Peak	Over Surface		Through Air	
0 - 50	0 - 70.7	3/64	(1.2)	3/64	(1.2)
51 - 125	72.1 - 176.8	1/16	(1.6)	1/16	(1.6)
126 - 250	178.2 - 353.6	3/32	(2.4)	3/32	(2.4)
251 - 500	355.0 - 848.5	1/2	(12.7)(b)	3/8	(9.5)(b)

a. On printed-wiring boards, their connectors, and board-mounted electrical components, wired on the load side of line filters or similar voltage peak reduction networks and components, a minimum spacing of 0.0230 inch (0.584 mm) plus 0.0002 inch (0.500 mm) per volt peak shall be maintained over surface and through air between uninsulated live parts and any other uninsulated live or dead conductive parts not of the same polarity.

b. Film-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 inch (2.4 mm) over surface and through air is acceptable between a dead metal part and film-coated wire that is rigidly supported and held in place on a coil.

Table 13: Power Supply Primary-Circuit Spacings Field-Wiring Terminals

Minimum Spacings (a), Inch (mm)

Potential Involved in Volts	Between Field-Wiring Terminals		Between Field-Wiring Terminals and Other Uninsulated Parts not Always of the Same Polarity			
	Through Air or Over Surface		Over Surface		Through Air	
0 - 50	1/8	(3.2)	1/8	3.2	1/8	(3.2)
51 - 250	1/4	(6.4)	1/4	6.4	1/4	(6.4)
251 - 600	1/2	(12.7)	1/2	12.7	3/8	(9.5)

a. These spacings apply to the sum of the spacings involved wherever an isolated dead metal part is interposed.

Table 14: Dimensions of Bushings

Trade Size of Conduct	Over-All Diameter		Height	
inches	inches	(mm)	inches	(mm)
1/2	1	(25.4)	3/8	(9.5)
3/4	1-15/64	(31.4)	27/64	(10.7)
1	1-19/32	(40.5)	33/64	(13.1)
1-1/4	1-15/16	(49.2)	9/16	(14.3)
1-1/2	2-13/64	(56.0)	19/32	(15.1)
2	2-45/64	(68.7)	5/8	(15.9)
2-1/2	3-7/32	(81.8)	3/4	(19.1)
3	3-7/8	(98.4)	13/16	(20.6)
3-1/2	4-7/16	(113)	15/16	(23.8)
4	4-31/32	(126)	1	(25.4)
5	6-7/32	(158)	1-3/16	(30.2)
6	7-7/32	(183)	1-1/4	(31.8)

32 INSULATING BARRIERS

An insulating barrier or liner used as the sole separation between uninsulated LIVE PARTS and grounded dead metal parts, including the ENCLOSURE, or between uninsulated LIVE PARTS of opposite polarity shall be of a material that is acceptable for the mounting of uninsulated LIVE PARTS and shall not be less than 0.028 inch (0.71 mm) thick.

Exception: Fiber less than 0.028 inch (0.71 mm) thick may be used as the sole separation between the ENCLOSURE and an uninsulated metal part electrically connected to a ground circuit conductor.

An insulating barrier or liner that is used in addition to an air space in place of the required spacing through air shall be at least 0.028 inch (0.71 mm) thick. If the barrier or liner is of fiber, the air space shall not be less than 1/32 inch (0.8 mm), and if the barrier or liner is of other material that is not acceptable for the support of uninsulated LIVE PARTS, the air space provided shall be acceptable for the application.

Exception: A barrier or liner that is used in addition to not less than one-half the required spacing through air may be less than 0.028 inch (0.71 mm) but not less than 0.013 inch (0.33 mm) thick if the barrier or liner:

a. Is of a material that is acceptable for the mounting of uninsulated LIVE PARTS,

b. Has the necessary mechanical strength if exposed or otherwise likely to be subjected to mechanical damage,

c. Is held in place, and

d. Is located so that it will not be adversely affected by operation of the EQUIPMENT in service.

e. Insulating material having a thickness less than that specified in this subhead may be used if investigated and found to be acceptable for the application.

33 SAFETY EARTH GROUNDING

All exposed dead metal parts that might become energized shall be connected to SAFETY EARTH GROUND. Refer to DEC STD 002-0 for preferred methods of making SAFETY EARTH GROUND connections.

33.1 PARTS TO BE CONNECTED TO SAFETY EARTH GROUND

Accessible conductive parts in OPERATOR ACCESS AREAS and SERVICE ACCESS AREAS which may assume a hazardous voltage in the event of a fault of basic insulation, shall be reliably connected to a SAFETY EARTH GROUND terminal in the EQUIPMENT. Such EQUIPMENT is deemed to be Class I.

Conductive parts behind a cover which does not withstand the requirements of subhead 1.1.5, Doors and Covers, are deemed to be accessible.

Other parts such as signal circuits and EMI screens may be connected to the SAFETY EARTH GROUND terminal but since such connections are not SAFETY EARTH GROUND connections they are not subjected to the requirements for SAFETY EARTH GROUND.

Parts in OPERATOR ACCESS AREAS need not be connected to SAFETY EARTH GROUND provided that they are separated from parts at hazardous voltages:

a. Either by metal connected to SAFETY EARTH GROUND or solid SUPPLEMENTARY INSULATION, or

b. By a clearance of not less than 13 mm (0.512 inch), in which case the accessible parts shall withstand the requirements under subhead 1.1, Enclosures, and all related parts shall be fixed in such a way that they cannot come into contact with each other due to a failure of fixing or termination or accidental displacement of removable covers.

For the purpose of the preceding subhead contact with OPERATIONAL or BASIC INSULATION of a conductor is regarded as contact with the conductor.

Exception: Internal dead metal parts that can be touched only by SERVICE PERSONNEL and that can become energized from a circuit involving ELECTRIC SHOCK at greater than FELV potential with reference to SAFETY EARTH GROUND or other accessible parts, need not be connected to the SAFETY EARTH GROUNDING means if a MARKING as described in DEC STD 178-3, subhead 11.22, Ungrounded Parts Service Hazard, is located on or adjacent to the part.

If two or more standalone UNITS are electrically or mechanically connected to one another and one of them is grounded, each UNIT of the system that has a separate supply cord shall have a supply cord that provides for SAFETY EARTH GROUNDING. If the UNITS are interconnected electrically by PRIMARY CIRCUITS, they shall be bonded together by means of a conductor or conductors of rated ampacity included in an acceptable interconnecting cable. In other words, the cord with SAFETY EARTH GROUND connectivity shall accompany the primary power in every interconnect of the EQUIPMENT.

Conductive coatings, if less than 1 megohm per square, must be connected to SAFETY EARTH GROUND or treated as an ungrounded metal part. As such, the requirements for insulation and spacing from LIVE PARTS must be met.

See DEC STD 119-2, Test method 119-TM-E12, for the method to determine ohms per square.

See DEC STD 002-0 subhead 6.4, Safety Earth Ground Wire Connection, for grounding of receptacles.

33.2 SAFETY EARTH GROUNDING MEANS

SAFETY EARTH GROUNDING CONDUCTORS shall not contain switches or FUSES.

If systems are made up of a group of Class I and Class II UNITS, the interconnection of the UNITS shall be such that SAFETY EARTH GROUNDING connection is assured for all Class I UNITS irrespective of the arrangement of the UNITS in the system. Internal SAFETY EARTH GROUNDING CONDUCTORS may be bare or insulated. If insulated, the INSULATION shall be green/yellow, except in the case of grounding braids, which may use transparent INSULATION, and in the case of special conductor assemblies, such as, ribbon cables, bus bars, and flexible printing wiring, and so forth, where green/yellow, transparent or bare may be used. The percentage of one color in the green/yellow wire shall be between 30% and 70% in any 15 mm (0.6 inch) length.

SAFETY EARTH GROUND connections shall not be such that disconnection of a SAFETY EARTH GROUND at one assembly may break the SAFETY EARTH GROUND connection to other assemblies.

If OPERATOR removable parts have a SAFETY EARTH GROUND connection, this connection shall be made before the current-carrying connections are established when placing the part in position, and current-carrying connections shall be separated before the SAFETY EARTH GROUND connection is broken when removing the part.

SAFETY EARTH GROUND connections shall be so designed that they do not have to be disconnected for servicing other than for the removal of the part which they serve or where removal of hazardous voltages from that part is accomplished at the same time.

Wires identified by the color combination green/yellow shall be used only for SAFETY EARTH GROUND connections.

Screw fasteners that obtain their holding feature by metal cutting (spaced thread sheet metal), and thread cutting shall not be used for making SAFETY EARTH GROUND connections.

Thread forming screw fasteners can be used for making SAFETY EARTH GROUND connections only if:

a. The thread forming is created by roll-forming.

b. The holding feature is accomplished by a full form standard machine screw thread.

If the fastener used for SAFETY EARTH GROUND connections is intended to be removed either during installation or by the user, then a minimum of two screw fasteners must be used for this connection. See DEC STD 002, subheads 6.4.1, Grounding Hardware and Surface, and 6.5, Safety Earth Ground Connection Methods.

The flexible metallic covering (braiding or sheath) of cables or cords carrying a hazardous voltage shall not be considered or used as the SAFETY EARTH GROUND CONDUCTOR. This metallic covering shall however, be connected to SAFETY EARTH GROUND.

33.3 SAFETY EARTH GROUNDING TERMINALS

SAFETY EARTH GROUNDING terminals for fixed supply conductors or for NON-DETACHABLE POWER SUPPLY CORDS shall comply with the requirements of subhead 1.22, Supply Connections, but screwless terminals shall not be used.

Terminals external to the EQUIPMENT shall not be used to provide SAFETY EARTH GROUNDING continuity between different parts of the EQUIPMENT.

The clamping means of SAFETY EARTH GROUNDING terminals shall be adequately locked against accidental loosening and it shall not be possible to loosen them without the aid of a TOOL. In general, the design commonly used for current-carrying terminals, other than some terminals of the pillar type, provide sufficient resiliency to comply with this requirement; for other designs special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently, may be necessary.

Compliance is checked by inspection and manual test.

In a permanently connected UNIT, a FIELD-WIRING TERMINAL or a lead intended solely for connection of an EQUIPMENT SAFETY EARTH GROUNDING conductor shall be provided.

The EQUIPMENT SAFETY EARTH GROUNDING connection shall not be made with a wire-binding screw. Refer to DEC STD 002 for connection methods.

The SAFETY EARTH GROUNDING terminal for the EQUIPMENT SAFETY EARTH GROUNDING CONDUCTOR shall be marked in accordance with DEC STD 178-3, subhead 11.5, External Safety Earth Grounding Connection. The pressure wire connector shall be so located that it will not be removed during intended servicing of the UNIT unless it is a part of the UNIT being replaced.

33.4 SAFETY EARTH GROUND PATH REQUIREMENTS

The SAFETY EARTH GROUNDING terminal shall be resistant to corrosion.

Compliance is checked by inspection and by reference to DEC STD 002-0 subhead 6.4.1, Grounding Hardware and Surface, and by the SAFETY EARTH GROUNDING tests.

34 LEAKAGE CURRENT

EQUIPMENT intended to be connected to TN power supply systems shall not have leakage current in excess of the values in Table 15.

Table 15: Maximum Leakage Current

Class	Type of Equipment	Maximum Leakage Current (mA)
II	All	0.25
I	Hand-held	0.75
I	Movable (other than Hand-held)	3.5
I	Stationary, pluggable	3.5
I	Stationary, permanently connected	3.5
I	Stationary, permanently connected equipment exceeding 3.5 mA and meeting specific requirements of this subhead.	5% of input current

CLASS I STATIONARY EQUIPMENT which exceeds a limit of 3.5 mA is subject to the following conditions:

a. Primary power and SAFETY EARTH GROUNDING CONDUCTORS of the power supply cable shall be permanently connected to the EQUIPMENT and to the building wiring.

b. Labeling must be present, as defined under DEC STD 178-3, subhead 11.1, High Leakage Current.

c. Leakage current shall not exceed 5% of the UNIT input current per phase. Where the load is unbalanced the largest of the three phase currents is used for this calculation. Where necessary, the tests in 119-TM-E6, Test Method for Leakage Current shall be used but with a measuring instrument of negligible impedance;

d. The cross-sectional area of the internal SAFETY EARTH GROUNDING conductor shall not be less than 16 AWG (1.5 mm^2) in the path of high leakage current.

e. In addition, it is recommended that a means of detecting failure of continuity of the external SAFETY EARTH GROUNDING conductor should be installed in all UNITS having more than 3.5 mA of leakage current.

For the purpose of this requirement CLASS I EQUIPMENT is considered to be permanently connected if supplied through a NON-DETACHABLE POWER SUPPLY CORD and an industrial plug and socket. Plugs and sockets conforming with IEC Publication 309 are deemed to comply. In North America NEMA twist lock plugs are allowed.

See DEC STD 002-0 for selection of plugs and sockets.

Compliance is confirmed by performing 119-TM-E6, Test Method for Leakage Current.

In order that the 3.5 mA requirement be achievable the maximum limit for any single UNIT shall not exceed 0.5 mA rms and for any power controller shall not exceed 1.5 mA rms.

34.1 SERVICE PROTECTION

34.1.1 Primary Circuits and Shock Hazards

Accessibility for servicing to PRIMARY CIRCUITS and other SHOCK HAZARDS shall not be provided by the same covers, guards or INSULATION which is normally removed for access to low voltage circuitry. Certain low voltage circuits such as regulators, harnesses, connectors, and so forth, may be included in the hazardous access area. These hazardous areas shall be marked as defined in DEC STD 178-3.

In SERVICE ACCESS AREAS, mechanical hazards or uninsulated parts operating at more than 42.4 V peak ac or 60 V dc shall be located or guarded so that unintentional contact with such parts is unlikely during servicing operations involving other parts of the EQUIPMENT. Refer also to subhead 1.12.2, Primary Power Isolation.

Uninsulated parts that involve an ENERGY HAZARD shall be located or guarded so that they are not likely to be bridged by conductive materials that might be present during service operations.

Required guards should be easily removable and replaceable if removal is necessary to service the protected parts.

A protective device provided to remove a stored-energy charge from an internal circuit shall operate automatically when the circuit is de-energized.

34.1.2 Moving Parts

Moving parts that can cause injury to persons, that must be in motion during servicing operations not involving the moving parts, shall be located or guarded so that unintentional contact with the moving part is not likely.

Compliance is verified by inspection.

34.1.3 Conductive Parts

All conductive parts that are accessible to SERVICE PERSONNEL and are usually expected to be at SAFETY EARTH GROUND potential (rubber cushion mounted motors, electronic chassis, and similar components) but are likely to become energized by a single fault condition from a circuit potential higher than ELV, shall either be connected to SAFETY EARTH GROUND or shall be marked in accordance with DEC STD 178-3, subhead 11.22, Ungrounded Parts Service Hazard.

34.1.4 Hot Surfaces

Surfaces in SERVICE ACCESS AREAS which normally operate at temperatures which:

a. Exceed those in Table E4-2 of Test Method 119-TM-E4 by less than 20 degrees K shall be labeled in accordance with DEC STD 178-5 requirements for hot surfaces.

b. Exceed those in Table E4-2 of Test Method 119-TM-E4 by more than 20 degrees K shall be guarded or protected, and labeled in accordance with DEC STD 178-5 requirements for hot surfaces.

NOTE

This requirement is not intended to apply to each and every component in service areas, such as semiconductors, integrated circuits, heatsinks, and so forth, when one or more labels already identifies the existence of hot surfaces in the area of the component. This does not preclude the need to label individual parts which are not expected to be hot in normal application or operation.

35 COMPONENTS AND APPLICATIONS

In order to establish whether or not safety is involved, a careful investigation of the circuit is recommended, to take into account the consequences of possible failure of COMPONENTS. This is generally only considered to be necessary for COMPONENTS operating at hazardous voltages. Consideration should also be given to parts for prevention of mechanical hazards (for example stabilizers, stability interlocks, chassis slides, gas springs).

The purchased COMPONENTS in Table 16 must be approved by the agencies for the specific country and the application of use.

Those COMPONENTS used in EQUIPMENT intended for sale in specific countries shall have test-house approval by an agency acceptable to that country. If no regulatory agency approval exists for that COMPONENT in that country, approval by UL, CSA, or an IEC accepted test-house is required.

Table 16: Purchased Components

Component	UL	CSA	Other
Air filters	x		
Capacitors *	x(2)		(1)
Cathode Ray Tubes (CRTs)	x	x	(3)
Circuit Breakers	x	x	
Conductive Coatings and Base Materials	x		
Connectors	x	x	
Direct plug in transformers and Power Supplies	x	x	
Fans above 30 volts rms	x	x	
Fiber optic cable	x		
Fuses	x	x	
Fuseholders	x	x	(3)
Interlock switches	x	x	(3)
Line filters	x	x	
Lithium batteries	x		
Plastics (resin)	x		(4)
Power cords and cord sets	x	x	(3)
Power supplies	x	x	(3)
Mains (branch circuit) connectors	x	x	
Primary circuit motors	x	x	
Primary circuit switches	x	x	(3)
Printed-wiring boards	x		
Printed-wiring board laminates	x		
Relays with either coils or contacts in primary circuits or secondary circuits that present a risk of shock hazard or energy hazard	x	x	(3)
Strain reliefs	x(5)	x(5)	(3)(5)
Subassemblies or products using primary power	x	x	(3)
Thermal controls	x	x	(3)
Varistors *	x	x	
Wire and Cable	x	x	(3)(6)
Wiring harnesses	x		(6)

* Primary, line-to-line, or, line-to-ground
(1) Capacitors in line filter applications require an agency approval.
(2) UL approval is not required for capacitors in filter applications.
(3) Approval to an IEC standard is required. Exact requirements vary by component and country. Contact either the Product Safety Engineer or Component engineer for applicable requirements for a given part.
(4) Requirements for Plastics (resins) are under consideration.
(5) Strain reliefs may also be approved in the application.
(6) Refer to DEC STD 119-1, subhead 1.2.6, Interconnecting Wiring Requirements.

35.1 CATHODE RAY TUBES (CRTs)

EQUIPMENT containing CRTs having a maximum face dimension exceeding 152 mm (6 inches) shall provide adequate protection against the effects of implosion and mechanical impact.

Either the CRT shall be of an implosion-protected type, or the ENCLOSURE of the EQUIPMENT shall provide the required implosion protection. See subhead 1.2.1.4, CRT Enclosures.

Compliance is checked by inspection, by measurement, and by the relevant tests of 119-TM-D13, Test Method for CRT Implosion.

36 MARKINGS AND INSTRUCTIONS

Sufficient information shall be provided to the user concerning any condition necessary to ensure that, when used as prescribed by the manufacturer or under conditions of likely misuse, the EQUIPMENT will not present a hazard within the meaning of this standard.

Where necessary to ensure that the EQUIPMENT remains safe within the meaning of this standard the manufacturer shall prepare and have available the necessary instructions for operation, installation, maintenance, transportation and storage.

Additional MARKINGS are allowed, provided they do not give rise to misunderstanding and that they conform with the requirements of DEC STD 178-3.

36.1 LANGUAGES, LABEL QUALITY, LABEL COLOR

Marking requirements for languages, and label quality are in DEC STD 178-3 and those for label color are contained in DEC STD 178-5.

36.2 PRODUCT RECALL INFORMATION

Recall information is required on all shipments of products.
Refer to DEC STD 178-3 which defines MARKING requirements which support product recall efforts.

36.3 SEPARATE INSTRUCTIONS AND MANUAL

In order to ensure that installation requirements are achieved for EQUIPMENT designed to be built-in and that depends on the installation conditions to meet the requirements of this standard, the instruction sheet for that EQUIPMENT is required to include clear information about:

a. Dimensions of the space to be provided for the EQUIPMENT.

b. Dimensions and position of the means to support and fix the EQUIPMENT within this space.

c. Minimum clearances between the various parts of the EQUIPMENT and the surrounding parts of the fitment.

d. Minimum dimensions of ventilating openings (if any) and their correct arrangement.

e. Connection of the EQUIPMENT to the supply and the interconnection of separate COMPONENTS, if any.

36.3.1 Installation and Power

The EQUIPMENT installation instructions shall state that the EQUIPMENT has not been designed for connection to an IT or TT POWER SYSTEM. The installation instructions must state the connections to SAFETY EARTH GROUND or other functional grounds required and other pertinent power system characteristics. For EQUIPMENT intended for connection to multiple RATED VOLTAGES or frequencies the method of adjustment shall be fully covered in the service manual or installation instructions.

If any overcurrent protection required is obtained from protection devices which are part of the building installation, they shall be specified in the EQUIPMENT installation instructions.

An installation-wiring diagram, other instructions, or both, shall accompany a UNIT if the details of wiring to the BRANCH-CIRCUIT power supply and the details of connections to air-conditioning, alarm, fire-extinguishing, or other EQUIPMENT are not obvious or are not marked on the UNIT.

If it is necessary to take special precautions when installing the EQUIPMENT, details shall be given in the installation instructions.

Special precautions may be necessary, for example, for connection of the EQUIPMENT to the supply and the interconnection of separate UNITS, if any.

If EQUIPMENT is not provided with a DISCONNECT DEVICE, the installation instructions shall state that:

a. For EQUIPMENT permanently connected to the primary power supply, a readily accessible DISCONNECT DEVICE shall be incorporated in the fixed wiring.

b. For EQUIPMENT connected to the primary power supply by means of a NON-DETACHABLE POWER CORD and a PLUG, the socket outlet shall be installed near the EQUIPMENT and shall be easily accessible.

CORD-CONNECTED EQUIPMENT shall be provided with instructions to indicate the type of plugs or cord sets that are to be used for connection to the alternate voltage.

36.3.2 Cathode Ray Tubes

For CRT containing products, the following data shall appear in the related technical manual. Anode voltage and dose rate data shall be those for the specific product. 1 mR/hr = 71.7 pA/kg:

Rated Anode Voltage: XX kV (fixed) [See Note]

Dose Rate: Less than X.XX pico amperes per kilogram (XX milli-Roentgens per hour) measured at a distance of 5 cm at any accessible point of the external surface.

NOTE

XX, in cathode ray tubes, is product specific.

36.3.3 Accessory Equipment

Accessory EQUIPMENT and conversion UNITS intended to be installed by qualified personnel shall include instructions either on or packed with each accessory EQUIPMENT or each conversion UNIT. The instructions shall provide a step-by-step outline of the mechanical and electrical alterations that are necessary for determining and providing proper installation and operation.

36.3.4 High Leakage Current

If the leakage current of a system exceeds 3.5 mA, the following instructions must be in a prominent place in the installation instructions:

a. An insulated SAFETY EARTH GROUND CONDUCTOR that is identical in size, INSULATION material, and thickness to the NEUTRAL and PHASE BRANCH-CIRCUIT supply conductors, except that it is green with one or more yellow stripes, is to be installed as part of the BRANCH CIRCUIT that supplies the UNIT or system.

b. The SAFETY EARTH GROUNDING CONDUCTOR mentioned in item (a) is to be connected to SAFETY EARTH GROUND at the service EQUIPMENT or other acceptable building SAFETY EARTH GROUND.

c. If the UNIT is plug-connected, the attachment-plug receptacles in the vicinity of the UNIT or system are all to be of a grounding type, and the SAFETY EARTH GROUNDING conductors serving these receptacles are to be connected to SAFETY EARTH GROUND at the service EQUIPMENT or other acceptable building SAFETY EARTH GROUND.

Refer to DEC STD 178-3 subhead 11.1, Leakage Current, for the required MARKING when the leakage current exceeds 3.5 mA.

37 MARKING PERTAINING TO ENCLOSURES

Refer to DEC STD 178-0, heading 4, Label Quality and DEC STD 178-3, subhead 11.35, Electrical Equipment Enclosures.

37.1 NAMEPLATE REQUIREMENTS

Refer to DEC STD 178-0, heading 4, Label Quality and DEC STD 178-3, heading 3, Marking Requirements For All Products, for nameplate requirements.

a. The proper wiring connections must be plainly marked. Wiring terminals shall be marked and the EQUIPMENT shall be provided with wiring information to indicate the connections. The wiring information shall be easily accessible to the installer.

b. EQUIPMENT for which an accessory kit is made available by the manufacturer for field or distributor modification shall be marked to identify the accessories that may be installed. For a product such as OPEN EQUIPMENT, for which the required MARKING may be on a separate sheet, the accessory information may also be on that separate sheet.

c. For EQUIPMENT that may be assembled in different combinations, all COMPONENTS shall be identified. Reference shall be made on the basic EQUIPMENT to all COMPONENTS that may be assembled together.

d. ENCLOSURES that require hubs to be attached at the time of installation shall have installation information regarding the use of suitable hubs and the location of the CONDUIT entry.

e. EQUIPMENT that is designed for use in CONTROLLED ENVIRONMENTS shall be marked with the following or equivalent.

"FOR USE IN A CONTROLLED ENVIRONMENT, REFER TO MANUAL FOR ENVIRONMENTAL CONDITIONS"
and
"EN CAS D'UTILISATION EN ATMOSPHERE CONTROLEE, CONSULTER LA NOTICE TECHNIQUE"

f. Wiring terminals shall be marked to indicate the proper connections for the power supply, load, control circuit, and the like, or a wiring diagram coded to the terminal MARKING shall be securely attached to the EQUIPMENT.

Exceptions:

1. The terminals need not be marked if the wire connections are plainly evident, as for a 2-terminal SWITCHING DEVICE.
2. A wiring diagram with multiple circuit arrangements may be provided loose or in an envelope provided the nameplate or similar permanent attachment, visible after installation, references the wiring diagram, for example, by number. For OPEN EQUIPMENT, the wiring diagram be furnished with the EQUIPMENT.

g. A terminal for the connection of a grounded supply circuit conductor shall be identified per DEC STD 002-0.

h. If low-voltage EQUIPMENT or a part of low-voltage EQUIPMENT is intended to be wired in the field to become only part of a Class 1 circuit or a Class 2 circuit wired with Class 1 wire, the terminals of the EQUIPMENT or part of the EQUIPMENT shall be marked accordingly. Low-voltage switching or power consuming EQUIPMENT or a part of the EQUIPMENT that is intended to be wired in the field to become part of a Class 2 circuit only shall be marked accordingly, but a low-voltage power supply device that includes a transformer is not required to be marked to indicate that it is acceptable for use in a Class 2 circuit only. Low-voltage EQUIPMENT or a part of EQUIPMENT that is acceptable for connection to either a Class 1 or a Class 2 circuit is not required to be so marked.

i. EQUIPMENT incorporating two or more separate circuits that are capable of being connected to separate power mains but that are intended to be connected to a common power main shall be marked, "All circuits must have a common disconnect and be connected to the same pole of the disconnect" or with an equivalent wording. The wiring diagram of the EQUIPMENT shall illustrate a typical connection of the various circuits connected to the common power main.

j. EQUIPMENT employing a special fitting for the connection to a specific wiring system shall be marked to indicate that it must be installed with such a wiring system.

k. EQUIPMENT that is acceptable for installation with a nonmetal-enclosed wiring system only shall be marked to indicate that it must be installed with such a wiring system.

l. EQUIPMENT having FIELD-WIRING TERMINALS shall be marked, "Use Copper Conductors Only" if the terminal is acceptable only for connection to copper wire.

m. A wiring terminal that is not intended to receive a conductor one size larger than that specified under subhead 1.22.1, Permanently Connected Equipment, item (b) shall be marked to restrict its use to the smaller size conductor.

37.2 CAUTIONARY MARKINGS

a. A cautionary marking intended to instruct the OPERATOR shall be legible and visible to the OPERATOR during the normal operation of the EQUIPMENT.

b. A MARKING that provides servicing instructions shall be legible and visible when such servicing is being performed.

c. If more than one disconnect switch is required to disconnect all power within a control assembly or compartment, the assembly or compartment shall be marked with the word "CAUTION" and the following or the equivalent:

   "Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing."

d. A live heat sink or other part likely to be mistaken as dead metal and exposed to persons shall be marked with the symbol for dangerous voltage. See DEC STD 178-5 Symbol A5036 (the lightening bolt). The MARKING shall be located on the LIVE PART or in close proximity so as to make the risk known before the part is likely to be touched.

e. The MARKING required for ENCLOSURES that are intended for field assembly of the bonding means, in accordance with subhead 1.7, Bonding, shall (1) be located where visible during installation, such as inside the cover, and (2) consist of the word "CAUTION" and the following or the equivalent:

   "Bonding between CONDUIT connections is not automatic and must be provided as a part of the installation", or the word "CAUTION" and the following or equivalent.

   "Nonmetallic ENCLOSURE does not provide grounding between CONDUIT connections. Use grounding bushings and jumper wires."

f. A push-button station or selector switch ENCLOSURE of insulating material that has no means for continuity of grounding between any CONDUIT provision shall be marked that only one CONDUIT is to be connected to the ENCLOSURE.

g. An overload relay or industrial equipment incorporating an overload relay shall be marked with the word "Warning" and the following or the equivalent. "To provide continued protection against a risk of fire and electric shock, the complete overload relay must be replaced if burnout of the current element occurs."

   Overload relays shall be equipped with replaceable thermal elements.

The above information shall also appear in the installation manual.

INDEX

A

Accessibility
  Design Requirements, 29
Accessory Equipment, Instructions and Manuals
  Design Requirements, 70

B

Blower Motors, 42
Bonding, 26
Bottom Plate
  Product Safety Acceptable, 9

C

Cast Metal, 1
Cathode Ray Tube
  See CRT
Cathode Ray Tubes
  See CRTs
Cautionary Markings, 73
Chemicals, Health Hazard
  Design Requirements, 34
Color
  Safety Earth Grounding Wire, 63
Components and Applications
  Design Requirements, 67
Conductive Parts, 66
Cord-Connected
  Equipment, 44
  Programming and Diagnostics Units, 44
Corrosion
  Protection Against, 24
Creepage and Clearance Distances, 50
CRT Enclosures
  Design Requirements, 11
CRT Implosion
  Design Requirements, 69
CRT Instructions and Manuals
  Design Requirements, 70
CRTs, 69
  Marking Requirements, 70

D

Decorative Parts, 22
Derived Low Voltage, 46
Design Requirements
  Accessibility, 29
  Chemical Health Hazard, 34
  Components and Applications, 67
  CRT Enclosures, 11
  CRT Implosion, 69
  ELV Circuits, 48
  Enclosure Material, 23
  Enclosure Openings, 7
  Exposure to Fire, 6
  External Parts Flammability, 22
  Flammability, 20
  Frame and Enclosure, 6
  Ignition Sources, 20
  Installation and Power Instructions, 70
  Instructions and Manuals, Accessory Equipment, 70
  Instructions and Manuals, CRT, 70
  Instructions and Manuals, High Leakage Current, 71
  Interconnection, Non-MELV Circuits, 48
  Internal Parts Flammability, 21
  Languages, 69
  Leakage Current, 65
  Liquid Health Hazard, 34
  MELV Insulation, 47
  MELV Protection, 48
  MELV Requirements, 46
  Multiple Supply Sources, 33
  Multi-voltage Equipment, 34
  Packaging, 71
  Parts to be Grounded, 62
  Primary Power Isolation, 31
  RF Radiation Health Hazard, 37
  Safety Earth Grounding and Bonding, 62
  Safety Earth Grounding Means, 63
  Safety Earth Grounding Terminals, 64
  Safety Earth Ground Path Requirements, 64
  Service Protection, 66

Design Requirements (Cont.)
X-Radiation Health Hazard, 36
Doors and Covers, 5

E

Enclosed Equipment
External Interconnections, 41
Enclosure Material
Design Requirements, 23
Enclosure Openings
Design Requirements, 7
Enclosures, 1, 15
Marking, 71
Outdoor, 24
External Interconnections, 41
Enclosed Equipment, 41
Open Equipment, 41
External Parts Flammability
Design Requirements, 22

F

FELV Circuits
Design Requirements, 48
Field Wiring, 27
Flammability
Decorative Parts, 22
Design Requirements, 20
Ignition Sources, 20
Internal Parts, 21
Forced Ventilation, 14
Frame and Enclosure, 6
Fuseholders, 39

G

Gaskets, 15

H

Health Hazard, Chemicals
Design Requirements, 34
Health Hazard, RF Radiation
Design Requirements, 37
Health Hazard, X-Radiation
Design Requirements, 36
High Leakage Current, Instructions and Manuals
Design Requirements, 71
Hot Surfaces, 66

I

Ignition Sources
Design Requirements, 20
Industrial Control Equipment
Mounting, 28
Installation and Power Instructions
Design Requirements, 70
Instructions, 69
Instructions and Manuals, Accessory Equipment
Design Requirements, 70
Instructions and Manuals, CRT
Design Requirements, 70
Instructions and Manuals, High Leakage Current
Design Requirements, 71
Insulating Barriers, 61
Insulating Material, 28
Interconnection Cords and Cables, 41
Interconnection with Non-MELV Circuits
Design Requirements, 48
Internal Parts Flammability
Design Requirements, 21
Internal Wiring, 39
Isolation Devices, 50

L

Label Color
Marking Requirements, 69
Label Quality
Marking Requirements, 69
Languages
Design Requirements, 69
Marking Requirements, 69
Leakage Current
Design Requirements, 65
Liquids, Health Hazard
Design Requirements, 34
Live Parts, 30

M

Marking Requirements
CRTs, 70
Label Color, 69
Label Quality, 69
Languages, 69
Markings, 69
MELV Insulation
Design Requirements, 47
MELV Protection
Design Requirements, 48
MELV Requirements
Design Requirements, 46
Mounting
Industrial Control Equipment, 28
Moving Parts, 66
Multiple Supply Sources
Design Requirements, 33
Multi-voltage Equipment
Design Requirements, 34

N

Nameplate Requirements, 71
Non-Ventilation Openings, 12

O

Open Equipment
External Interconnections, 41
Openings, 7
Bottom, 7
Sides, 11
Top, 10
Overcurrent Protection
Power Supplies, 37

P

Packaging
Design Requirements, 71
Parts to be Grounded
Design Requirements, 62
Permanently Connected Equipment, 42
Polymeric Material, 4
Power Supplies
Overcurrent Protection, 37
Power Supply
Primary Circuits, 37
Secondary Circuits, 38
Primary Circuit Capacitors, 39
Primary Circuits, 31
Shock Hazards, 66
Primary Power Isolation
Design Requirements, 31
Product Recall Information, 69
Programming and Diagnostic Units
Cord-Connected, 44
Protection, Service
Design Requirement, 66

R

Radiation Hazards
Design Requirements, 36
RF Radiation
Health Hazard
Design Requirements, 37

S

Safety Earth Grounding and Bonding
Design Requirements, 62
Safety Earth Grounding Means
Design Requirements, 63
Safety Earth Ground Path Requirement
Design Requirements, 64
Safety Grounding Terminals
Design Requirements, 64
Separation of Circuits, 49
Service Protection
Design Requirements, 66
Sheet Metal, 1
Shock Hazards
Primary Circuits, 66
Spacings, 50
Splice Insulation, 40
Supply Connectors
Wiring Terminals and Leads, 42

T

Telecommunication Circuit Interconnection, 48
Top Cover Designs
Product Safety Acceptable, 10
Transformers, 41

V

Ventilation Openings, 12
Barriers, 13
Circuit Breakers, 13
Fuse, 13

W

Windows
Mechanical, 14
Observation, 14
Wiring Colors
Safety Earth Grounding, 63
Wiring Terminals and Leads
Supply Connectors, 42

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